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ABSTRACT

This curriculum packet includes a teacher's introduction and five curriculum units that explore how transportation needs affect the environment, including the quality of air and water, habitat, and global climate. These materials encourage teens to apply wisdom, ingenuity, and sound science to the choices they make. Units are: (1) "Introduction--Going Places, Making Choices"; (2) "Unit 1--Cruise through History, A Look at Where We've Been and Where We're Going"; (3) "Unit 2--Natural Resources and Energy Use"; (4) "Unit 3--Sweating Over Climate Change, Air Pollution and Climate Change"; (5) "Unit 4--Land Use, Leaving Our Imprint on Earth"; and (6) "Unit 5--A Matter of Choice, Going Places, Making Choices, Taking Action." (CCM)

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Going Places, Making Choices: Transportation and the Environment Curriculum Designed for Grades 9-12.

Contains:

---introduction, resources & references
---Unit 1: Cruise Through History
---Unit 2: Natural Resources and Energy Use
---Unit 3: Sweating Over Climate Change
---Unit 4: Land Use
---Unit 5: A Matter of Choice

SE 063 252

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going places, making choices

introduction, resources, & references

TRANSPORTATION AND THE ENVIRONMENT

The National 4-H Council mission is to be an uncommon youth development organization fostering innovation and shared learning for youth workers and young leaders.

This curriculum was generously underwritten by Honda North America, Inc.

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TRANSPORTATION AND THE ENVIRONMENT

EMBARK ON A new LEARNING adventure!

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

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previewing other units

Unit	Topics	Learning Goals	Activities
Unit 1 CRUISE THROUGH HISTORY: A Look at Where We've Been and Where We're Going	*Transportation and community changes during the past two centuries.* *Environmental impacts of transportation.*	■ TO LEARN ABOUT THE ROLE TRANSPORTATION HAS PLAYED IN SHAPING THE PHYSICAL AND SOCIAL INFRASTRUCTURE OF THIS COUNTRY; ■ TO INTERACT WITH COMMUNITY MEMBERS TO RESEARCH THE CHANGES THAT HAVE OCCURRED IN THEIR COMMUNITIES; ■ TO INVESTIGATE PAST, PRESENT, AND FUTURE TRANSPORTATION OPTIONS.	**1a** Where We've Been **1b** Moving Forward Faster
Unit 2 NATURAL RESOURCES AND ENERGY USE	*Impacts of nonrenewable and renewable resource use in transportation.* *Personal transportation choices and how they affect the environment.*	■ TO UNDERSTAND THE DIFFERENCE BETWEEN RENEWABLE AND NONRENEWABLE RESOURCES; ■ TO DISCUSS ENVIRONMENTAL IMPACTS OF ENERGY USE; ■ TO OFFER PERSPECTIVES ON THE HIDDEN COSTS OF TRANSPORTATION; ■ TO USE ASSESSMENTS TO HELP BETTER UNDERSTAND HOW PERSONAL HABITS AFFECT ENERGY CONSUMPTION; ■ TO CONSIDER ALTERNATIVE WAYS TO CONSERVE ENERGY.	**2a** Personal Transportation Assessment **2b** Walking Around
Unit 3 SWEATING OVER CLIMATE CHANGE: Air Pollution and Climate Change	*Threats from air pollution, ozone depletion, and global warming.* *Potential responses to air quality threats.*	■ TO EXPLAIN WHY GLOBAL WARMING, OZONE DEPLETION, AND AIR POLLUTION ARE SERIOUS ENVIRONMENTAL THREATS; ■ TO LIST EXAMPLES OF AIR POLLUTANTS AND GREENHOUSE GASES; ■ TO COMPARE PAST AND PRESENT CLIMATE AND EMISSION DATA AND PROJECT FUTURE TRENDS; ■ TO ANTICIPATE HOW THINGS MAY CHANGE IN THEIR LIFETIMES AND ANALYZE WHAT ACTIONS MIGHT BE TAKEN TO ALTER THE CURRENT PROJECTIONS.	**3a** Simulating the Greenhouse Effect **3b** Data and Trend Forcasting

Unit	Topics	Learning Goals	Activities
Unit 4 LAND USE: Leaving Our Imprint On the Earth	*How transportation systems and choices affect land use.* *How communities use zoning and other means to plan for growth and transportation.*	■ TO EXPLORE HOW TRANSPORTATION CHOICES AFFECT LAND USE, LIFESTYLE, AND ENVIRONMENT; ■ TO DETERMINE WHAT IS MEANT BY SUSTAINABILITY; ■ TO LEARN HOW THE LAND USE PROCESS IS CONDUCTED IN COMMUNITIES AND WHO DECIDES HOW LAND IS USED; ■ TO DISCOVER OPTIONS FOR DESIGNING OUR COMMUNITIES.	**4a** Land Ho! Settling a Brand New Place **4b** Resolving National Park Land Use Conflicts
Unit 5 A MATTER OF CHOICE: Going Places, Making Choices, Taking Action	*Personal values and decisions about environmental and transportation issues.*	■ TO LEARN HOW PERSONAL VALUES SHAPE THE EVERYDAY WORLD—FAMILY LIVES, EDUCATION, POLITICS, FAITH, VISION, AND HOW THEY CHOOSE TO SPEND MONEY; ■ TO INVESTIGATE PERSONAL VALUES AND HOW THEY AFFECT THE CHOICES THEY ALL MAKE AS INDIVIDUALS AND CONSUMERS—AT THE MALL, ON MAIN STREET, AT SCHOOL, WORK, PLAY, ETC.	**5a** What's Driving Our Decisions? **5b** Gear up for Community Service

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introduction, resources, & references

going places, making choices

TRANSPORTATION AND THE ENVIRONMENT

Introduction

Today's youth inherit a legacy of past decisions that have created great opportunities and challenges. We designed Going Places, Making Choices to help youth understand and respond to real-life issues affecting their communities and lives.

These units focus on transportation and mobility issues. Choices that we make to meet our transportation needs profoundly affect how land is used in our communities and regions. Our choices affect the environment, including the quality of our air and water, habitat, and possibly even global climate.

In these materials, we use transportation as the hub from which to explore environmental sciences, culture, and value systems. Our perceptions, beliefs, and attitudes hold the key to what must be done to make our world livable in the future.

These materials encourage teens to apply wisdom, ingenuity, and sound science to the choices they make. In today's world, teens must be able to assess complex issues, understand interdependencies, and reason and make choices that will ultimately lead to a sustainable world.

consider this:

What does it mean to be a teenager today?

- The gasoline shortage of the 1970s was over for more than a decade by the time today's teen was born. They have no knowledge of long gas lines or hoarding.
- The world added 1.5 billion people during their short lifetime. That's equal to the whole world population growth from 1650 to about 1940.
- U.S. energy consumption climbed from 74 quadrillion BTUs to more than 95 quadrillion BTUs during their lifetime. Interestingly, this was less than the increase from 1960 to 1975.
- And, some really important facts: Teens don't know what a pull-top can is; they've never played PacMan; and they've never eaten a beige M&M.

Source: The World Almanac 1999. *Mahway, New Jersey: World Almanac Books.*

Curriculum Goals

1. Help learners make informed transportation choices as individuals, consumers, and citizens.

2. Encourage learners to take action that reflects personal commitment to environmental health balanced with mobility needs.

3. Help learners develop and use critical thinking skills and take meaningful action.

4. Encourage learners to construct a framework of past, current, and future scientific assessments (facts, observations, conclusions, etc.) on which to base their decisions as consumers and citizens.

> "This **curriculum** is a great tool that **empowers** teens to **make decisions** in their own lives today, which they know will make a **difference** to the world they will inherit **tomorrow.** My students loved it!"
>
> – Donna P. Pugh, Teacher, Levelland, Texas

Meeting National Educational Standards Through Environmental Studies

The Going Places, Making Choices curriculum is designed to be used by teachers or leaders across the nation. In preparing these materials, we used national frameworks, notably the National Research Council's *National Science Education Standards*, the American Association for the Advancement of Science's *Benchmarks for Science Literacy*, and the competency areas outlined as competency areas for youth development (see page 3 box) to ensure that they met goals for environmental education and youth development.

Using the Curriculum

There are five units in Going Places, Making Choices, in addition to this introductory guide. They include:

- **Unit 1:** A Cruise Through History: A Look at Where We've Been and Where We're Going
- **Unit 2:** Natural Resources and Energy Use
- **Unit 3:** Sweating Over Climate Change: Air Pollution and Climate Change
- **Unit 4:** Land Use: Leaving Our Imprint on the Earth
- **Unit 5:** A Matter Of Choice: Going Places, Making Choices, Taking Action

The curriculum is designed to be used by leaders and teachers with youth ages 14 and older. You'll act as facilitator for your group of learners. Within each unit, however, there are opportunities for self-directed learning by students. For example, chapter background information can be photocopied and given directly to teens. Additionally, some activities are meant to be completed by teens independently.

These materials were created with today's busy teacher or leader in mind. A flexible format allows you to use the entire program or just one unit. Each unit contains the following repeating elements:

Tourguide Notes contain the learning goals and expectations of the unit, along with website resources.

five basic competency areas for youth development

All materials provided by National 4-H Council strive to develop youth who will become successful, contributing adults. The subject matter of this curriculum, therefore, is based in part upon the five basic competency areas identified by Pittman (1991) as essential for success in adulthood:

1. **Health and Physical Competence** - Good current health status plus evidence of knowledge, attitudes, and behaviors that will ensure future health.

2. **Personal and Social Competence** - Skills for understanding self and having self-discipline; working with others, communicating, cooperating, negotiating, and building relationships; coping, adapting, and being responsible; and finally, making good judgments, evaluating, making decisions, and problem-solving.

3. **Cognitive and Creative Competence** - Useful knowledge and abilities to appreciate and participate in areas of creative expression for thinking, seeing, feeling, tasting, and hearing.

4. **Vocational Competence** - Understanding and awareness of life planning and career choices, leisure and work options, and steps to act on those choices.

5. **Citizenship Competence** - Understanding of personal values, moral and ethical decision-making, and participation in public efforts of citizenship that contribute to the community and the nation.

Source: Center for 4-H Youth Development, Understanding Youth Development Work, (FO-6699-C). Minnesota Extension Service, 1996.

THE UNIT BACKGROUND CONTAINS INFORMATION THAT YOU CAN PHOTOCOPY AND DISTRIBUTE TO STUDENTS. THIS INFORMATION INTRODUCES THE TOPIC AND PROVIDES A BASIS FOR LEARNING MORE (BY DOING THE ACTIVITIES). THE UNIT BACKGROUND INFORMATION COVERS FROM FOUR TO SEVEN PAGES. AT THE END OF EACH BACKGROUND, YOU'LL FIND QUESTIONS IN A SECTION CALLED *THINGS TO THINK ABOUT*. STUDENTS CAN USE THESE QUESTIONS TO DISCUSS THE INFORMATION THEY'VE READ.

UNIT ACTIVITIES ARE LESSON PLANS THAT YOU CAN USE TO GET YOUTH MOVING AND LEARNING! WITHIN ACTIVITIES, YOU'LL FIND HANDOUTS, ASSESSMENT TOOLS, AND IDEAS FOR EXTENDING THE LEARNING.

Documented Learning Assessments

Going Places, Making Choices provides assessment tools for your use in documenting learning. Because today's teaching styles and environments are so varied, these tools can be modified to meet your particular needs.

Students may maintain portfolios that will help you assess their learning. They can use three-ring binders to store information. The following may be included in a portfolio:

- PHOTOCOPIES OF UNIT BACKGROUNDS;
- WRITTEN RESPONSES TO THINGS TO THINK ABOUT (QUESTIONS FROM THE UNIT BACKGROUNDS);
- COMPLETED ACTIVITY SHEETS AND OTHER WRITTEN DOCUMENTATION;
- OPTIONAL ARTICLES ABOUT TRANSPORTATION AND ENVIRONMENTAL ISSUES.

You can collect these portfolios for review. They also may serve as the basis for science or county and state fair projects.

Using Outside Resources

These days, it's not what you know, but how fast you can find the needed information. Today's learners (and teachers) face an overwhelming amount of resources in libraries, books, and on the internet. As the human population grows, more people think, communicate, and post their thoughts. Teens must understand how to access and assess information.

The following pages list some excellent contacts and internet spots to start them on their journey. Refer to these resources when completing Units One through Five.

resources

Environmental and Alternative Transportation Organizations

CLIMATE INSTITUTE
324 4th Street NW
Washington, DC 20002
202.547.0104
www.climate.org

EARTH FORCE
1908 Mount Vernon Ave., 2nd. Fl.
Alexandria, VA 22301
703.299.9400
www.earthforce.org
email earthforce@earthforce.org

EARTH ISLAND INSTITUTE
300 Broadway, #28
San Francisco, CA 94133
415.788.3666
www.earthisland.or
email earthisland@earthisland.org

ENVIRONMENTAL DEFENSE FUND
257 Park Ave., South
New York, NY 10010
212.505.2100
www.edf.org

ENVIRONMENTAL POLICY INSTITUTE
218 D Street, SE
Washington, DC 20003
202.544.2600

GLOBAL TOMORROW COALITION
1325 G St., NW #915
Washington, DC 20005-3104
202.628.4016

GREENHOUSE ACTION
2120 N. 140th Street
Seattle, WA 98133
206.361.0282

GREENPEACE USA
1436 U St., NW
Washington, DC 20009
202.462.1177
www.greenpeace.org

INSTITUTE FOR ENERGY AND
ENVIRONMENTAL RESEARCH
6935 Laurel Ave.
Takoma Park, MD 20912
301.270.5500
www.ieer.org

LEAGUE OF AMERICAN BICYCLISTS
1612 K Street NW, Suite 401
Washington, DC 20006
202.822.1333
www.bikeleague.org

NATURAL RESOURCES DEFENSE COUNCIL
40 W. 20th Street
New York, NY 10011
212.727.2700
www.nrdc.org
email nrdcinfo@nrdc.org

SIERRA CLUB
85 Second Street, 2nd Fl.
San Francisco, CA 94105-3441
www.sierra.org

UNION OF CONCERNED SCIENTISTS
Two Battle Square
Cambridge, MA 02238-9105
617.547.5552
www.ucsusa.org
email ucs@ucsusa.org

US CLIMATE ACTION NETWORK
1350 New York Ave. #300
Washington, DC 20005
uscan@igc.org

WORLD RESOURCES INSTITUTE
10 G Street NE, Suite 800
Washington, DC 20002
202.729.7600
www.wri.org

WORLDWATCH INSTITUTE
1776 Massachusetts Ave., NW
Washington DC 20036
202.452.1999
www.worldwatch.org
email worldwatch@worldwatch.org

Industry Organizations

ALLIANCE FOR A RESPONSIBLE CFC POLICY
2111 Wilson Blvd, #850
Arlington, VA 22201
703.243.0344

AMERICAN WIND ENERGY ASSOCIATION
122 C Street NW
Washington, DC 20001
www.igc.apc.org/awea
email windmail@awea.org

EDISON ELECTRIC INSTITUTE
701 Pennsylvania Ave., NW
Washington DC 20004
202.508.5000
www.eei.org

ELECTRIC POWER RESEARCH INSTITUTE
3412 Hillview
Palo Alto, CA 94304
650.855.2000
www.epri.com

GEOTHERMAL ENERGY ASSOCIATION
1025 Thomas Jefferson Street NW, Suite 109
Washington, DC 20001
www.geotherm.org
email gea@geotherm.org

GLOBAL CLIMATE COALITION
1275 K Street NW, Suite 890
Washington, DC 20005
202.682.9161
www.globalclimate.org

NATIONAL COAL ASSOC.
1130 17th St., NW
Washington DC 20036
202.463.2651

NUCLEAR ENERGY INSTITUTE
1776 I St., NW #400
Washington, DC 20006
202.739.8000
www.nei.org
email webmasterp@nei.org

SOLAR ENERGY INDUSTRIES ASSOCIATION/NATIONAL BIO-ENERGY INDUSTRIES ASSN.
122 C Street NW
Washington, DC 20001
www.seia.org

STEEL RECYCLING INSTITUTE
1.800.937.1226
www.recycle-steel.org
email sri@recycle-steel.org

WESTERN FUELS ASSOC.
1625 M St., NW
Washington, DC 20036-3264
202.463.6580
www.westernfuels.org

Government

EXECUTIVE OFFICE OF THE PRESIDENT
The White House
1600 Pennsylvania Ave., NW
Washington DC 20500
202.456.1414
www.whitehouse.gov

COUNCIL ON ENVIRONMENTAL QUALITY
722 Jackson Place NW
Washington, DC 20503
202.456.6224
www.whitehouse.gov/CEQ

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
1600 Pennsylvania Avenue NW
Washington, DC 20502
202.395.7347
email information@ostp.eop.gov

OFFICE OF US GLOBAL CHANGE RESEARCH PROGRAM
300 D St., SW #840
Washington DC 20024
202.554.6470

PRESIDENT'S COUNCIL ON SUSTAINABLE DEVELOPMENT
730 Jackson Place NW
Washington, DC 20503
202.408.5296
www.whitehouse.gov/PCSD
email pcsd.comments@erols.com

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BUREAU OF OCEANS, ENVIRONMENT, SCIENCE AND TECHNOLOGY
202.647.0978

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Washington, DC 20590
202.366.4000
www.dot.gov

DEPARTMENT OF ENERGY
1000 Independence Ave. SW
Washington, DC 20585
www.doe.gov

OVERALL CLIMATE POLICY
202.586.3890

EFFICIENCY AND RENEWABLES
202.586.8252

ECONOMIC AND ENVIRONMENTAL POLICY
202.586.5827

GLOBAL ENVIRONMENTAL STUDIES CENTER
Oak Ridge National Laboratory
P.O. Box 2008
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University of California
Atmospheric and Geophysical Sciences Division
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Livermore, CA 94550
925.422.1100
www.llnl.gov

LAWRENCE BERKELEY NATIONAL LABORATORY
Mail Stop 50A-4133
Berkeley, CA 94720
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Public Information Office: 415.486.5771

LOS ALAMOS NATIONAL LABORATORY
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Los Alamos, NM 87545
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
Goddard Institute for Space Studies
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New York, NY 10025
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www.nasa.gov

UPPER ATMOSPHERE RESEARCH PROGRAM
Washington DC 20546
202.358.0237

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)
14th and Constitution Ave., NW
Washington DC 20230
202.482.6090
www.noaa.gov

AIR RESOURCES LABORATORY
1315 East-West Hwy.
Silver Spring, MD 20910
301.713.0684

CLIMATE AND GLOBAL CHANGE PROGRAM
301.427.2089

CLIMATE MONITORING AND DIAGNOSTICS LABORATORY
Boulder, CO 80303
303.497.6966

ENVIRONMENTAL RESEARCH LABORATORIES
325 Broadway
Boulder, CO 80303
303.497.6000
www.erl.noaa.gov

NATIONAL CLIMATIC DATA CENTER
Federal Building 151 Patton Ave.
Asheville, NC 28801
828.271.4800
www.ncdc.noaa.gov
email questions@ncdc.noaa.gov

NATIONAL METEOROLOGICAL CENTER CLIMATE ANALYSIS CENTER
World Weather Building, #606
5200 Auth Rd.
Camp Springs, MD 20746
301.763.8016

NATIONAL OCEAN SERVICE
1305 East-West Highway
Silver Spring, MD 20910
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NATIONAL WEATHER SERVICE
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Silver Spring, MD 20910
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OFFICE OF GLOBAL PROGRAMS
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www.ogp.noaa.gov

OFFICE OF OCEAN AND EARTH SCIENCES
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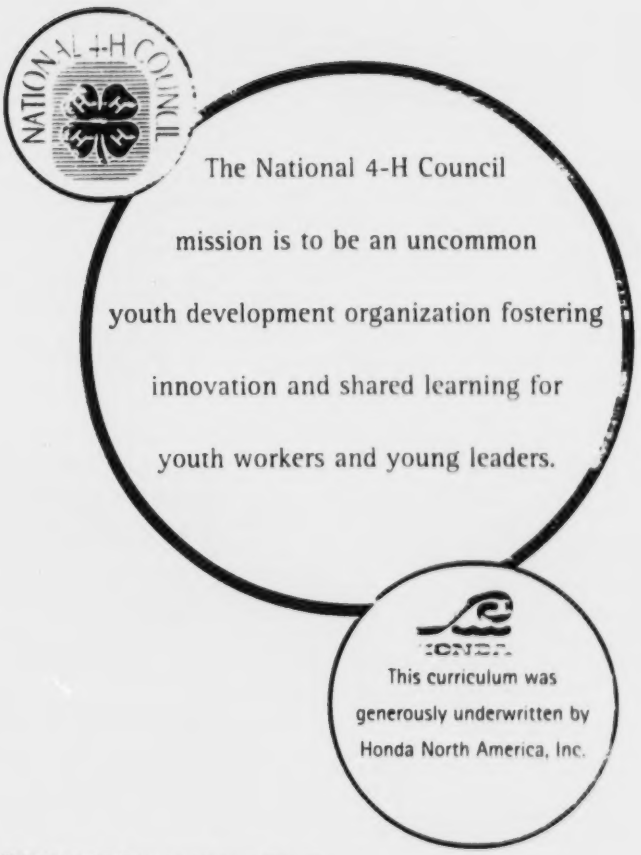
cruise through hist

unit 1

A LOOK AT WHERE WE'VE BEEN AND WHERE WE'RE GOING



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cruise through history

unit 1

A LOOK AT WHERE WE'VE BEEN AND WHERE WE'RE GOING

EMBARK ON A **new** LEARNING **adventure!**

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

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Introduction

CRUISE THROUGH HISTORY
A LOOK AT WHERE WE'VE BEEN
AND WHERE WE'RE GOING

TOURGUIDE NOTES	Unit Destination Learning Objectives	1
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Unit 2	Natural Resources and Energy Use
Unit 3	Sweating Over Climate Change: Air Pollution and Climate Change
Unit 4	Land Use: Leaving Our Imprint on the Earth
Unit 5	A Matter of Choice: Going Places, Making Choices, Taking Action

Website Resources

The websites listed here will give students access to ideas and information. Please note these addresses can change. Students can use keywords such as transportation, automobiles, bicycling, walking, mass transit, bus transportation, railroads, and airlines to search the Internet and find other sites. Let them explore!

- GOING PLACES, MAKING CHOICES
  www.fourhcouncil.edu/ycc/gpmc/index.html
- NATIONAL GEOGRAPHIC ONLINE
  www.nationalgeographic.com
- TEXAS TRANSPORTATION INSTITUTE
  www.tti.tamu.edu/
- VIRGINIA MUSEUM OF TRANSPORTATION
  www.vmt.org
- U.S. DEPARTMENT OF TRANSPORTATION – NATIONAL TRANSPORTATION LIBRARY
  www.bts.gov/NTL/

cruise through history

TOURGUIDE NOTES

Unit Destination

The goal of Unit 1 is to investigate how transportation has changed our lifestyles and our environment. By looking back through history we can understand how the choices we make today will affect our lives and our planet tomorrow.

Learning Objectives

Students will:

- LEARN ABOUT THE ROLE TRANSPORTATION HAS PLAYED IN SHAPING THE PHYSICAL AND SOCIAL INFRASTRUCTURE OF THIS COUNTRY;
- INTERACT WITH COMMUNITY MEMBERS TO RESEARCH THE CHANGES THAT HAVE OCCURRED IN THEIR COMMUNITIES;
- INVESTIGATE PAST, PRESENT, AND FUTURE TRANSPORTATION OPTIONS.

UNIT BACKGROUND

Walk, bike, ride, or fly—how we get around says a lot about our lives. To define the American spirit, for example, we need look no further than the garage. The automobile represents the ideal that founded this country—freedom. Freedom keeps the automobile close to the heart of Americans today.

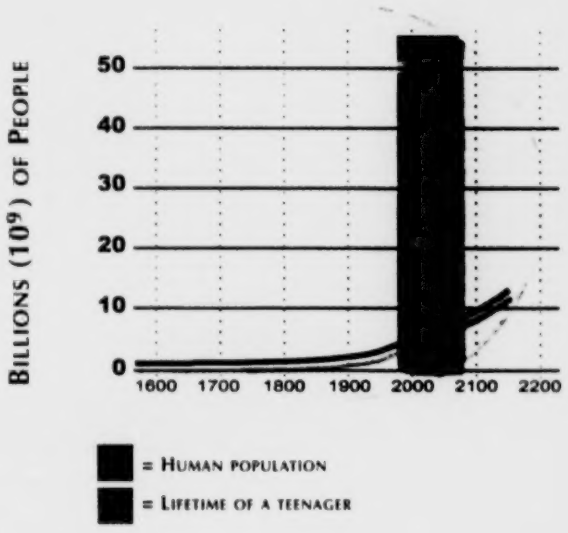
That's just one example of how transportation influences, and is influenced by, who we are and what we do. Advances have brought access to places previously out of reach. They have redefined where we can live and work. They have changed our concept of time, our sense of place, and our ability to explore frontiers—from "out West" in the 1800s to outer space today. In fact, transportation can be viewed as one of the leading forces in the evolution of civilization.

Transportation Through Time

Historians divide the United States's past into three distinct phases: the agrarian period, the industrial period, and the service/information age. Teens were born during the service/information age. Their grandparents were born during the industrial period. Transportation is an important part of all three.

AGRARIAN PERIOD (up to the mid-1800s)

In the agrarian period, small cities served as ports for trade of agricultural goods. Early American cities were less than 20 square miles—about 4 to 5 miles end to end. People walked or rode horses. These cities, however, were just a small part of the story. At the beginning of the 1800s, more than 95 percent of the country's 3.9 million people (mostly farmers) lived in rural areas.

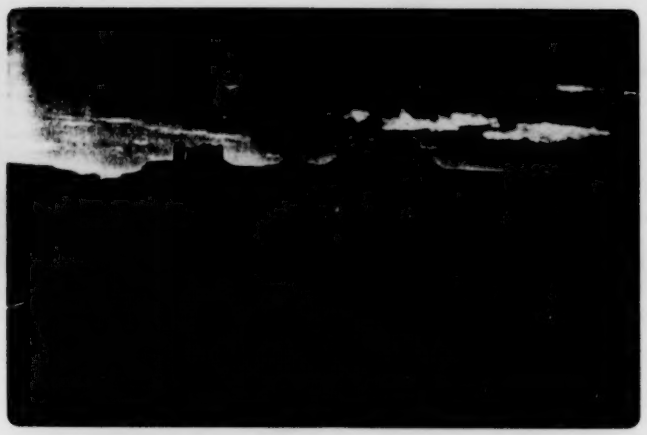


With news that the United Nations reduced its global population projections recently, it's apparent that human numbers are stabilizing. But it may be too early to celebrate. Though the explosion may be booming softer, the world population is still expected to reach 8.9 billion by 2050, up from about 6 billion today, and almost 11 billion by 2150. The United States is expected to expand by about half, to almost 400 million people, by the year 2050.

Sources:

-Brimelow, Peter. 1999. "Slower explosion: World population growth may be slowing, but don't cheer yet." Forbes, Jan 25, 1999 p58(1).

open road



To most Americans there is nothing like freedom of the open road!

INDUSTRIAL PERIOD (late 1800s to the mid-1900s) Around the 1830s cities changed dramatically. The Industrial Revolution brought massive migration and large population growth to the United States. People flocked to cities, where they were close to manufacturing jobs. In New York City, it is said that the streets were as congested in the 1800s as they are today! Horses were the main form of transportation. At one point these horses were polluting the city streets with more than 2.5 million pounds of manure and 60,000 gallons of urine every day.

By 1860 about half of all Americans lived in cities. Public transportation developed in the form of trolley cars. By the beginning of the 20th century, trolley cars radiated out like spokes from urban centers to growing residential areas. In Chicago, 15 private electric streetcar companies vied for street space. Chicago responded to growing congestion by elevating its streetcars. New York City put them below the street—the forerunner of today's subway system.

In the latter part of the 1800s, people who wished to get from New York to California no longer had to rely on wagon trains or long boat trips. Railroads opened America to settlement and exploration by the masses. People began moving around like never before.

Then came the automobile. This innovation gave people even more freedom to travel where they wanted, when they wanted. They didn't have to synchronize schedules with trolley or train. By the 1920s, automobile drivers began complaining about the lack of roads. An enormous and expensive infrastructure of roads and highways began to take shape. In 1956, lawmakers authorized development of 45,500 miles of interstate highways.

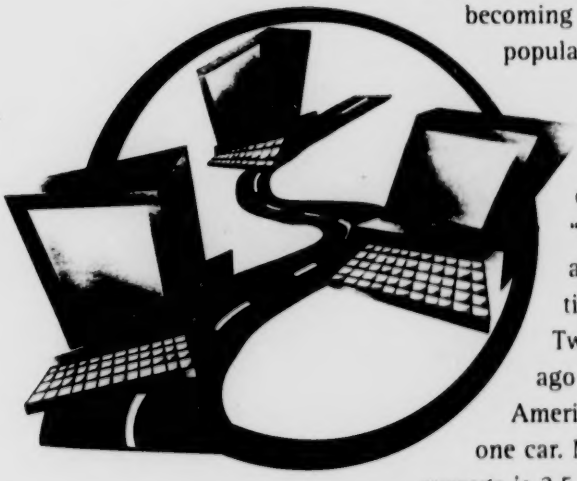
SERVICE/INFORMATION AGE (mid-1900s to the present) Today's shift from an

it's a fact...

EIGHTY-SIX PERCENT OF THE **population growth** IN THE UNITED STATES SINCE 1970 HAS OCCURRED IN THE **suburbs.**

- MICHAEL MEYER, GEORGIA INSTITUTE OF TECHNOLOGY, QUOTED IN "TRANSPORTATION'S PERENNIAL PROBLEMS," SCIENTIFIC AMERICAN, OCTOBER 1997.

industrial economy to a service/information economy is having as profound an impact on transportation as did the shift from the agricultural period to the industrial period. Less tightly bound to urban centers for employment, people are moving to the suburbs and beyond. Computers and the internet offer freedom from traditional workplaces. Telecommuting is becoming increasingly popular.



Despite the advances in electronic "travel," the use of automobiles continues to grow. Twenty-five years ago a typical American family had one car. Now the family average is 2.5 cars. This number may continue to increase. In many other countries, transit such as rail, bike, boat, and foot travel predominate. But in America, the automobile continues to be the "way to go."

The Price of Getting Around

Each form of transportation has both benefits and costs. For example, the convenience of driving a car is offset by many things. Think bumper to bumper traffic, the expense of gas and car insurance. Imagine how much money is needed for taxes to support roads and infrastructure.

In the past we have not always included all costs when evaluating various kinds of transportation. For example, consider the calculation of the real cost of automobile use. We may neglect to include the environmental cost of obtaining the raw materials needed to manufacture the car. We may forget to figure out the cost of transforming habitat into highway.

it's a fact...

EUROPEANS **make** 40 TO 50 PERCENT OF THEIR **trips** BY WALKING OR BIKING AND ABOUT 10 PERCENT BY **public transit.** IN CONTRAST, 87 PERCENT OF TRIPS IN THE UNITED STATES ARE BY CAR; ONLY 3 PERCENT INVOLVE PUBLIC TRANSIT.

-JOHN PUCHER, RUTGERS UNIVERSITY

Today, economists and environmentalists want us to remember such hidden costs. This practice is known as full cost accounting. Considering all costs is critical if we want to strike a balance between the health of the

environment and our lifestyle needs when developing transportation policy.

Environmental Awareness Comes of Age

To many, Earth Day 1970 was a wake-up call to the industrialized world about the unhealthy state of the environment. Well before today's teens were born, people were beginning to realize the earth couldn't clean up every mess humans made. In the ensuing 30 years:

- COMMUNITIES AND INDIVIDUALS HAVE BEEN RECYCLING HOME WASTE.
- BUSINESSES BEGAN TO CONSIDER THE ENVIRONMENT IN PLANNING AND MANAGEMENT.
- AUTOMOBILE MANUFACTURERS HAVE BEEN EXPLORING ALTERNATIVE FUELS, REDUCING EMISSIONS, AND IMPROVING FUEL ECONOMY.
- POWER PLANTS HAVE PLACED NEW EMPHASIS ON GENERATING ELECTRICITY FROM WIND, BIOMASS, AND WATER INSTEAD OF FROM COAL AND OTHER, MORE POLLUTING ENERGY SOURCES.
- LAWMAKERS HAVE ENACTED HUNDREDS OF ENVIRONMENTAL LAWS TO ADDRESS THE EFFECTS OF HUMAN ACTIVITY. THESE LAWS DEAL WITH AIR POLLUTION (CLEAN AIR ACT), WATER POLLUTION (CLEAN WATER ACT), MINING IMPACTS (SURFACE MINING CONTROL AND RECLAMATION ACT), WASTE DISPOSAL (OCEAN DUMPING ACT), AND WILDLIFE PRESERVATION (ENDANGERED SPECIES ACT), TO NAME A FEW.

Americans have already made an astounding investment in reducing our impact on the environment. More investments are part of

our future. However, we can reduce the need for such investment if we think ahead and pay attention to environmental issues. We must try to prevent (not just clean up) pollution.

One way to think ahead is to consider the environmental impacts of a product over its entire life cycle, from creation to disposal to material reuse. Traditionally, we have thrown products away when we're done with them. Think about it. Today's teens have thrown away millions of Barbie shoes and Star Wars action figures. Yesterday's toys, along with billions of other goods, are today buried deep within landfills.

Today, we have laws that require manufacturers to take back products. For example, computer companies take back products from customers and recycle all the parts. The plastic shells are melted down for reuse. Glass from monitors goes back to glass manufacturers. Metal from chipboards is extracted and disposed of safely or reused where possible. In the future, automobiles and other transportation vehicles could be dismantled and recycled in a similar way.

a brief history of transportation

3500-3000 B.C.	**Use of wheel by Sumerians and in the Fertile Crescent Region between the Mediterranean Sea and the Persian Gulf.**
A.D. 900	Horse collar and horseshoe are introduced to Western civilization from the East.
1400	Canal lock is perfected in Italy, creating a general expansion of canal building.
1420	Prince Henry the Navigator establishes a school where astronomers, mapmakers, and ship designers explore the science of navigation and sailing advances.

1832	**First horse-drawn omnibuses go into operation in New York.**
1840-1860	U.S. railroad system grows from just 2,818 miles of track to more than 30,000 miles of track.
1867	First elevated cable car begins operating in Manhattan.
1869	Union Pacific and Central Pacific Railroads meet at Promontory Point, Utah, achieving the first transcontinental rail link in the United States.

1880	**Popular use of geared bicycle is viewed as liberating women with a socially acceptable form of mobility.**
1885	German inventor Carl Benz constructs a motorized tricycle that travels at a speed of eight miles per hour.
1895	Boston begins using underground rail system for intracity transportation.
1903	First flight of Wright Brothers.
1914	First intercity bus line is established from Hibbing, Minnesota to neighboring towns.

1916	**Federal Aid Road Act funds improvement of rural public roads over which U.S. mail is transported.**
1919	Oregon is the first state to levy gasoline taxes • Every state follows its example within a decade.
1920	There are 3.5 million registered cars and trucks in the United States • Coast-to-coast U.S. airmail service begins.

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1928 Pacific Greyhound Lines provides first continental bus system in the United States

1930 **Commercial airline service begins in the domestic United States.**

1941 Network of electric interurban trolley lines is abandoned • First diesel locomotive goes into operation, leading to the phaseout of steam locomotives.

1950 The 10 million trucks in the United States haul an average long-distance load per truck of almost 9.75 tons over an average distance per trip of almost 240 miles • Eleven million bicycles are produced worldwide • Eight million automobiles are produced and 53 million automobiles are in use worldwide • Suburban growth begins • Bus systems replace urban trains and trolleys.

1956 The Highway Act of 1956 gives impetus to development of interstate highways and raises the federal gasoline tax to $.03/gallon.

1957 **USSR launches Sputnik I**

1960 The U.S. Population is 182 million • Thirteen million automobiles are produced and 98 million are in use worldwide.

1968 First air pollution controls are installed on new cars.

1970 First Earth Day • Clean Air Act amendments give federal government more power to regulate emissions • More than 23 million automobiles are produced and 194 million are in use worldwide.

1973 **Oil embargo leads to national energy crisis • Speed limits are reduced to 55 miles per hour by the U.S. Congress.**

1976 First TransAmerica bicycle route is dedicated.

1978 Corporate Average Fuel Economy (CAFE) regulations are adopted.

1980 Some 29 million automobiles are produced and 320 million are in use worldwide.

1990 **Mountain bike use booms • Speed limit control is returned to states • About 36 million automobiles are produced and 445 million are in use worldwide.**

1995 More than 2,306 electric vehicles are in use in the United States • More than 109 million bicycles are produced worldwide.

1997 **The U.S. Environmental Protection Agency tightens air quality standards for ozone and particulate matter • Analysts project a doubling of the world automobile fleet in 25 years.**

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things to think about

Discuss these questions in small teams or as part of a larger group.

1. Name the phases in the United States that guided us into an urban society and discuss how they have affected transportation and land use.

2. What is happening to cities as the service/information age continues to develop? How does this affect automobile use?

3. How many cars are in use worldwide today? Do you think this figure will continue to grow? Explain your answer.

4. What world event occurred in 1973 that led to a national energy crisis? What did the U.S. Congress do to address the problem?

5. Pick one of the events in the timeline and describe how it changed transportation options and the lifestyles of the population.

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where we've been

activity 1a

notes for instructors

Subjects: Social Science, Language Arts.

Activity Outcomes:
Students should be able to:

- DESCRIBE THE HISTORY AND EVOLUTION OF TRANSPORTATION IN THEIR COMMUNITY;
- FEEL MORE COMFORTABLE WITH INTERPERSONAL AND INTERVIEW SKILLS.

Time Required: 30 minutes for introduction and discussion; two to four hours for research; one hour for processing results and constructing timeline.

Equipment and Materials: Tape recorders, notepads, pens or pencils, and optional camcorders for interviews; art paper, markers, and tape; copies of Activity 1a handouts #1 and #2.

Special Notes: This activity can be done by individual students instead of teams.

Activity Overview

This activity is designed to help learners understand how their community has changed over time and the role transportation played in that change. In this activity, teens pick from a variety of options to construct a Transportation Timeline.

From Benchmarks for Science Literacy:

In the past century, agricultural technology led to a huge shift of population from farms to cities and a great change in how people live and work.

Doing the Activity

How has the community in which students live changed over time? Unlike the days of the horse and buggy, people can now live dozens of miles from their work and school. Peoples' lives play out in an ever-widening distance, all facilitated by advances in transportation.

Divide students into teams of two to four each. As an introduction to the topic, hand out copies of the Unit Background from this book. Each team is responsible for reading and understanding the material. After they are finished, they should spend time within the team discussing the questions from *Things to Think About*, found on page 8. (Answers are found in the back of this book.) Rotate among the teams while their discussions are ongoing.

To further their understanding of changes that have directly affected their lives,

activity 1a

students will construct a group transportation timeline. Each team will be responsible for researching their community and the changes wrought by transportation, such as automobiles, highways, and mass transit. If teams are researching a small town, they can do a broad investigation.
If they live in a large city, however, they may want to concentrate on one specific region of the city.

All students are seeking to answer the same question: *How have changes in local transportation changed people's lives over the past century?*

Give teams different options to conduct their research, as follows:

Option I: *Interview.* Conduct interviews with elders in the community about changes in transportation and lifestyles over the decades. Give teams choosing this option the Activity 1a handouts #1 and #2.

Option II: *Guest Speaker.* Bring a guest speaker, preferably a historian or someone who knows quite a bit about the changes to the area, to the classroom. Each team should be responsible for compiling a list of questions beforehand. Teams should take turns asking the speaker questions after he or she is finished with prepared comments.

Option III: *Library and Internet Research.* Old newspapers and books about the history of your community can provide valuable clues to the changes in the last century.

Option IV: *Field Trip.* If your community has such a resource, a trip to a history center or community museum would provide excellent insight into community changes.

THE TIMELINE

The timeline is a group project. After their research is completed, the group will use art paper, markers, or other media to construct a timeline. Teens will start by drawing an axis and titling their timeline (e.g., "Change Comes to Chattanooga.")

They next will begin to fill in the timeline, starting with the earliest date and working up to the most current. For example, they may list "1917—First automobile in area," "1992—Bicycle path paved."

Discuss the timeline with the group. Pick a date, and ask them how an event (such as first paved road) changed their lives. You may need to help them envision what life would be like without roads. Would there be automobiles? How would that affect their current lives? How would they get where they were going?

Other questions that can be used to spark debate include:

- WHAT WAS THE AREA'S MAIN WAY OF GETTING AROUND 100 YEARS AGO? FIFTY YEARS AGO? WHAT IS IT TODAY?
- IMAGINE YOU WERE INVITED TO A PARTY ON A COLD WINTER DAY. THE WIND IS HOWLING

AND EVEN THE ICICLES ARE SHIVERING. THE PARTY IS ABOUT FOUR MILES AWAY. NOW IMAGINE IT'S 1900. DO YOU GO, AND IF SO, HOW WILL YOU GET TO THE PARTY? NOW IMAGINE IT'S 50 YEARS AGO. AGAIN, DO YOU GO, AND IF SO, HOW DO YOU GET THERE? FINALLY, WOULD YOU GO TODAY?

- HAVE YOU NOTICED ANY CHANGES IN YOUR LIFETIME IN HOW PEOPLE GET AROUND?
- WHAT ONE TRANSPORTATION EVENT CHANGED THE COMMUNITY THE MOST, IN YOUR OPINION?
- WHAT DO YOU THINK IS THE MOST NEGATIVE CHANGE TO YOUR COMMUNITY, AND WHY? THE MOST POSITIVE, AND WHY? WHAT ROLE DID TRANSPORTATION PLAY IN THESE CHANGES?
- HOW DO YOU THINK THE COMMUNITY WILL CHANGE DURING THE NEXT 20 YEARS?
- HOW DO YOU THINK CHANGES IN TRANSPORTATION HAVE AFFECTED THE ENVIRONMENT IN YOUR AREA?

Checking Progress

How well did teens work together in a group to study the history and evolution of transportation in their community? Did they communicate well with the others? Did they speak and write persuasively? Did they express opinions and ask incisive questions? Did the team organize well to accomplish their interview or other research?

Optional Ideas

Music Reflects Transportation History. To further show how transportation has shaped society over time, collect and play songs about transportation from various times in history. You may wish to collect sheet music and invite the group to sing along. Examples: A Surrey with a Fringe on Top; I've Been Working on the Railroad; Riding on the City of New Orleans (Steve Goodman); Bus Station Blues (John Lee Hooker).

where we've been

activity 1a
handout #1

the interview!

Your job is to interview older members of the community to learn how your community has changed over time, and what role transportation has played in that change.

You'll need:

- A pen or pencil
- A pad of paper

optional:

A tape recorder or camcorder. Be sure to ask permission before you record!

What should you do first? Here are some tips for conducting a good interview:

- Find a person to interview! Sometimes, you'll know just who you want to talk to (a relative, family friend, etc.). Other times, you'll need to dig a little deeper. Identify five interview prospects by asking friends, neighbors, relatives, and business people for names.
- Consider interviewing someone who has lived 80 or more years. Some people this age live in nursing homes. Many residents would welcome visits and the chance to be interviewed. Contact the director of a nursing home or senior-care center to arrange for interviews.
- Telephone the person you want to interview. Introduce yourself and explain your project. Ask if the person is willing to meet with your team.
- Write out all the interview questions ahead of time. But don't be a robot! People like to talk about their memories. Sometimes what seems like a detour may yield excellent information.
- Don't be afraid to ask the person you are interviewing to slow down, or repeat something you missed. Ask them to explain a point more fully if it's unclear. Be alert during the interview, and be thinking about what the interviewee is saying. Try to make the interview more of a conversation so it's more enjoyable.
- Twenty minutes or so is enough time for your interview, unless you are invited to stay longer. **Take careful and complete notes!** People talk fast, and it's hard to get all the information down. More than one team member should take notes.
- Write a thank you note as follow-up.

activity 1a
handout #2

Here are some questions to get you started. Add your own, too!

Remember to try and get approximate dates that correspond with the answers, so you can build the timeline.

1. How long have you lived in this area?

2. What was it like to live here when you were my age?

3. How did you get to school when you were young? To the stores? To gatherings?

4. Where did most of the people in this area live, in town or on farms?

5. What's the first car you remember?

6. Was there a train station here, and, if so, where was it?

7. Did you ever leave the area for vacations or other activities? How did you travel?

8. What was the biggest change you remember related to transportation in this community?

9. How has transportation changed the community, in your opinion?

moving forward faster

activity 1b

notes for instructors

Subjects: Social Science, Math, Earth Science.

Activity Outcomes:
Students should be able to:

- EXAMINE PEOPLE'S PERCEPTIONS ABOUT FUTURE CHANGES TO THE COMMUNITY'S TRANSPORTATION METHODS AND NEEDS;
- DESIGN AND CONDUCT A SCIENTIFIC INVESTIGATION;
- USE EVIDENCE TO GENERATE EXPLANATIONS;
- CRITIQUE EXPLANATIONS AND PROCEDURES.

Time Required: Three to four hours.

Equipment and Materials: Copies of handouts for activity 1b; posterboard and markers.

Activity Overview

In this activity, teams of five design a survey, collect and interpret data, and present findings to the larger group about the future of transportation in their communities.

From National Science Education Content Standards

Standard A Science as Inquiry: Design and conduct a scientific investigation. Clarify the method and controls, organize and display data, and publicly present the results with a critical response from peers.

Doing the Activity

What will the future of transportation look like in your community? Will it look completely different due to mass transit because of a rapidly growing population? Will there be more cars on more roads? Will people need to go farther and farther to get to where they are going? Is your community shrinking, so that some transit services are being lost?

Give students an opportunity to explore the future of transportation locally while they learn some solid research skills. Collecting and interpreting data are important skills they will use during their lifetimes. Start by dividing youth into teams of about five each. If they haven't read the Unit Background in this book, give them an opportunity to read this material and discuss the questions on page 8 in their teams. (Answers are found in the back of this book.) Rotate among the teams while their discussions are ongoing.

activity 1b

This activity is fairly team-directed. Give each team copies of handouts #1 and #2 and review them with teams. They will follow the directions on the sheets to plan, conduct, and report their survey research. They will need about 45 minutes to formulate research questions; about 30 minutes to interview others in the room; about one hour to tabulate and analyze data and prepare visual aids and reports; and about one hour to report findings (five to 10 minutes per team). Be available to answer questions as they conduct these steps.

When teams are ready to analyze data, they will need posterboards and markers. Have these supplies ready.

REPORTING RESULTS TO THE LARGE GROUP
Each team has about five to 10 minutes to report the results of their survey. Encourage others in the room to ask questions and analyze how well teams designed surveys, collected data, and analyzed results.

Some questions you may wish to ask teams include:

- What was the hardest part of doing the research?
- Are there any questions you can think of now that you wish you had asked?
- Did your data surprise you? How?
- Do you think that city planners and other officials use surveys to plan transportation? Why or why not?
- Do you think our "center of town" will change? If so, how?
- Ask the large group what the responses and surveys mean. How is their community and its modes of transportation changing? What conclusions can they make from all the data?

Checking Progress

If you plan to ask students to keep portfolios, introduce this now (see Introduction and Resource Guide).

Optional Ideas

This class-based activity could be extended to include interviews of community members. This would strengthen the data base and make it more useful to community leaders. County or city transportation planners, city managers or board members, or other government officials would be interested to see the results of such a survey. Ask an official to meet with your group so members can present the results of their surveys. Find out exactly what changes are planned for your area, in terms of growth and transportation, over the next few decades.

moving forward faster

activity 1b
handout #1

Which direction is your community headed?

Is it a city growing even bigger, with highways and roads being added all the time? Do you live in a small town, with no signs of population growth, where people rely considerably upon automobiles to get where they are going?

Work in teams to design a survey, collect data, and find the answers to this research question:

How will the growth of population in your area affect transportation over the next 25 years?

OR, if the next statement is closer to what is happening in your community:

How will the loss of population in your area affect transportation over the next 25 years?

Designing a Survey

Your team will design a series of questions that will help you answer the research question. The first step is to define what you think is happening in your community. Is the population shrinking? Growing? How are these changes affecting how people get around? Is your area adding more mass transportation, such as buses or light-rail transit? More highways? More bicycle paths? Discuss what you think is happening with your team. This discussion should lead to some questions for your survey.

Give people a chance to agree, disagree, or remain neutral (no opinion) to your questions. For example, you may make a statement, like: *I think more people will ride bikes to get around in our area over the next few decades.*

You can then give them three choices for their answers: Agree, Neutral, Disagree.

Your team should write at least seven, but not more than 20, questions that will answer how population change is affecting transportation in your community. Write these questions on handout #2. You'll need to make enough copies of the survey for everyone in your team to have at least one copy.

moving forward faster

activity 1b
handout #2

Collecting Data

The other people in the larger group will be the population you'll sample. In other words, survey people that aren't members of your team, but are in your class or club.

To start, make sure that everyone in your team has a survey form with questions and a pencil or pen. Everyone in your team should find at least one person in the room to survey. Ask the questions and write responses. When you're done, get back together with your team.

Processing Data

Now it's time to analyze your data. One person should rewrite all the questions onto a sheet of paper, leaving room between them. Now, assign numbers to responses as shown below:

Agree = 1 Neutral = 2 Disagree = 3

Team members should record their answers, using numbers, for each question. For example, if your team interviewed five people, your first question's responses might look like this on your sheet: 1, 1, 3, 2, 1.

Repeat this step for every question, until you've recorded all responses. Next, find the mean for each answer. The mean is the sum of all the numbers, divided by the number of responses. For our example above, this would look like: (1 + 1 + 3 + 2 + 1)/5 or 1.6.

But what does the mean tell us? Well, if 1 = Agree, and 2 = Neutral, then the people you surveyed sort of agreed, but were somewhat neutral, about your question. A mean of 2.4 for the same question would translate into respondents pretty much disagreeing, but being somewhat neutral.

Obviously, the more people you survey, the closer your data reflect the population you are sampling.

activity 1b
handout #3

Reporting Your Data

Next, assemble your data so that you can report to the larger group. Each team will give a five-minute presentation to the larger group. Your team may want to draw pie or bar charts for each question on posterboard, to show the results visually. Be sure to discuss with the group what the results mean, and how they answer the question of how the growth (or decline) of the local population will change transportation during the next 25 years.

What happens if you have some results that don't (in your team's opinion) make sense? This happens sometimes in research! Your team will need to think about why the answers don't fit what you expected. Be sure to report this explanation to the larger group.

activity 1b
handout #4

Name of Person Interviewed_____ Name of Interviewer_____

Age of Person Interviewed_____ Gender of Person Interviewed _____

Q #__ _____

A ( ) Agree Neutral Disagree

Q #__ _____

A ( ) Agree Neutral Disagree

Q #__ _____

A ( ) Agree Neutral Disagree

Q #__ _____

A ( ) Agree Neutral Disagree

Q #__ _____

A ( ) Agree Neutral Disagree

Q #__ _____

A ( ) Agree Neutral Disagree

answers
from page 8

Things to Think About

Answer #1: During the agrarian period, cities covered less than 20 square miles. Most people lived outside the cities. During the industrial period, many people moved into cities to live near manufacturing jobs. This resulted in high population densities and a shift to the era of public transportation. After the automobile was introduced, people could move out of the crowded cities. They used their cars to get to work and stores. Highways were built and cities sprawled. The service and information age has supported dispersal of people and jobs to fringes of urban centers.

Answer #2: During the service information age, cities have become dispersed, causing auto use to increase. People have to drive farther to reach shopping, schools, churches, and other amenities.

Answer #3: About 500 million cars are in use worldwide today. This figure is expected to grow. As countries become industrialized, their demands for goods—including automobiles—grow. Major cities of the world continue to sprawl, yet don't necessarily increase their levels of public transportation.

Answer #4: The oil embargo led to the U.S. energy crisis. Congress established a nationwide speed limit of 55 mph to conserve gasoline.

Answer #5: Depends on chosen event.

National 4-H Council is a nonprofit organization that partners with 4-H, the Cooperative Extension System and other organizations to pursue its vision, implement its strategies, and accomplish its mission to be an uncommon youth development organization fostering innovation and shared learning for youth workers and young leaders.

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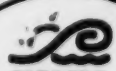
natural resources and energy

unit 2

The National 4-H Council mission is to be an uncommon youth development organization fostering innovation and shared learning for youth workers and young leaders.



This curriculum was generously underwritten by Honda North America, Inc.

natural resources and energy use

unit 2

EMBARK ON A new LEARNING adventure!

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

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Unit 5 A Matter of Choice: Going Places, Making Choices, Taking Action

Website Resources

The websites listed here will give students access to ideas and information. Please note these addresses can change. Students can use keywords such as renewable resources, nonrenewable resources, resource use, energy, and energy use to search the Internet and find other sites. Let them explore!

- GOING PLACES, MAKING CHOICES
  www.fourhcouncil.edu/ycc/gpmc/index.html
- U.S. ENVIRONMENTAL PROTECTION AGENCY ENERGY STAR PROGRAM
  www. epa.gov/energystar/
- DEPARTMENT OF ENERGY MOTOR CHALLENGE PROGRAM
  www.motor.doe.gov/mchal.htm
- WESTERN ENERGY SERVICES
  www.energy.wsu.edu/org/western/

natural resources and energy use

unit 2

TOURGUIDE NOTES

Unit Destination

The goal of Unit 2 is to explore the relationship between transportation and natural resource consumption. Students will learn about global and national energy supplies, explore how we use natural resources in our day-to-day lives, and identify what individual and societal actions people can take to manage energy consumption.

Each mode of transportation consumes energy at different rates. Shifting to more efficient transportation methods can significantly reduce energy consumption. By looking at natural resource supply and demand, students can better understand how our mobility choices affect future generations and the environment.

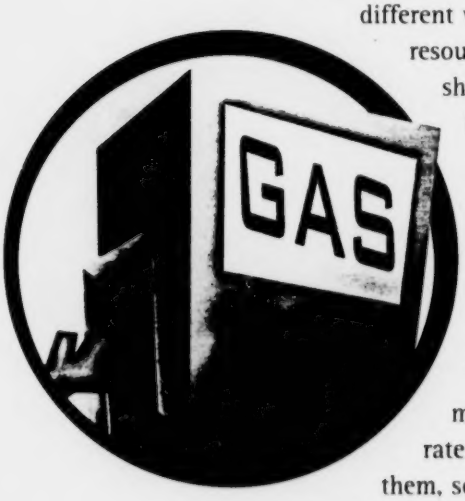
Learning Objectives

Students will:

- UNDERSTAND THE DIFFERENCE BETWEEN RENEWABLE AND NONRENEWABLE RESOURCES;
- DISCUSS ENVIRONMENTAL IMPACTS OF ENERGY USE;
- OFFER PERSPECTIVES ON THE HIDDEN COSTS OF TRANSPORTATION;
- USE ASSESSMENTS TO HELP BETTER UNDERSTAND HOW PERSONAL HABITS AFFECT ENERGY CONSUMPTION;
- CONSIDER ALTERNATIVE WAYS TO CONSERVE ENERGY.

UNIT BACKGROUND

Try to imagine a world without the natural resources we use to fuel our cars, light our homes, and pave our highways. A far different world? You bet! Natural resources run our cars, rocket ships, video games, factories . . . practically our entire lives.



For a long time people have behaved as though natural resources were limitless. We know, however, that many are finite. At the rate we use them, some may not last through the next generation. And even if every person reduces the amount of resources he or she uses, needs will continue to increase. Why is this? Because the human population is growing. This means that we face some big changes over the coming decades.

Renewable and Nonrenewable

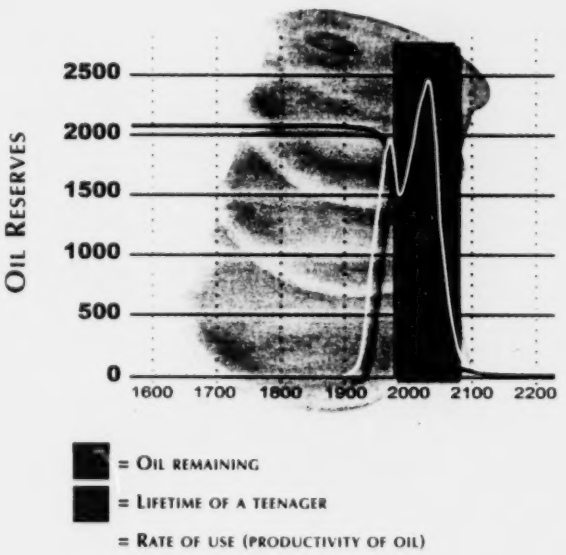
We can divide all sources of energy and materials into two categories: renewable and nonrenewable.

Nonrenewable resources include minerals (e.g., aluminum, tin, copper) and fossil fuels (e.g., coal, oil, natural gas). They exist in limited quantities and can't be replenished by natural processes within the foreseeable future. For example, fossil fuels, which are the remnants of prehistoric organisms, take millions of years to form.

Renewable resources are resources that can grow again and will last (as long as they are not overexploited). Renewable resources include trees, fish, fertile agricultural soil, and crops, among other things. Renewable energy resources come from geothermal sources, and from the wind and sun.

All forms of transportation—walking, riding a bus, riding your bike or horse, or driving a car—use energy. However, some forms use

Consider this:



In the lifetime of a teenager...

The United States will move into the next century with less than 30% of its original oil supply.

As adapted from Global 2000 Revisited, Gerald O. Barney

energy that can be renewed, and some use energy that can't be renewed.

Environmental Impacts

Every form of transportation carries with it some type of environmental impact. These include not only direct impacts, such as air pollution from burning fuel, but also hidden costs, such as creating and maintaining roads and bridges. Each travel mode (trains, planes, buses, etc.) has its own infrastructure and corresponding environmental costs.

Political Considerations

Environmental impact is not the only cost of using energy and other resources. There are also political costs. Countries and businesses that control energy resources wield power. Nonrenewable resources, such as oil, are like money in the bank. The more a country controls, the more powerful it is. However, unlike money in the bank, resources do not increase in amount or accumulate interest. Countries can save or spend them, but once they're gone, they're gone.

Because of this, energy is viewed as a national security issue. This was made clear when the United States felt the consequences of the 1973 and 1978 Middle East oil embargoes. The disruption upset our economy and raised national security concerns. These embargoes led to quick action by the government to enact energy conservation measures. More recently, the Gulf War (in the early 1990s) reflected our country's continued interest in preserving strategically important Middle East oil supplies.

Reducing Impacts

People demand energy and natural resources. Los Angeles residents alone drive 142 million miles—the distance from Earth to Mars—every single day. Americans drive more than two trillion vehicle miles per year. We each use more than 480 gallons per year of gasoline—more than twice the rate of Sweden, our closest competitor. One reason for this is that gas is cheaper in the United States. But Americans also love the freedom that comes with driving a car!

Some people think technology will save us from having to think about

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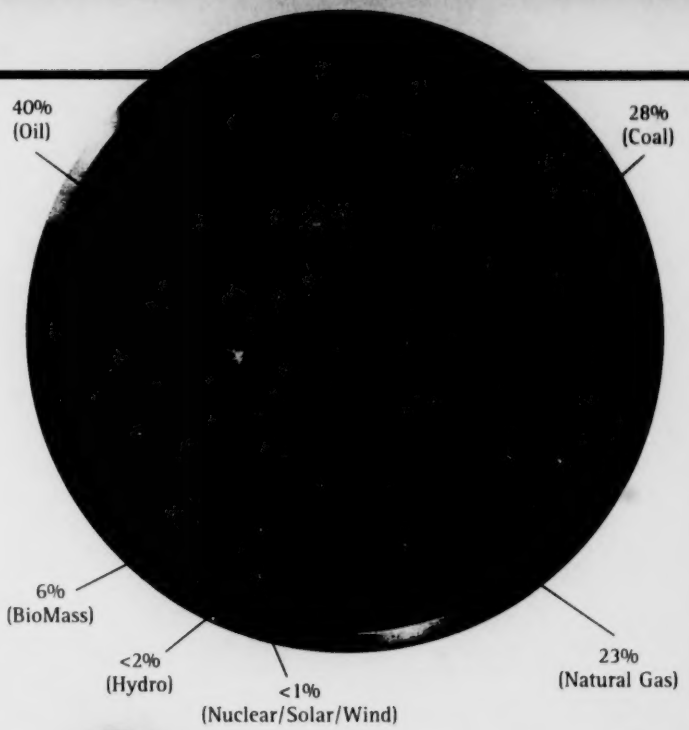
selected sources of energy from natural resources:



Oil: 40%

(nonrenewable) Oil is the world's largest energy source. Known oil reserves are being depleted.

Coal: 28%

(nonrenewable) Coal is the most plentiful fossil fuel. Just three countries—China, Russia, and the United States—own 57% of the world's coal reserves.

Natural Gas: 23%

(nonrenewable) Natural gas accounts for 18% of the world's current annual energy budget. This share is likely to increase as gas replaces oil in a number of uses. Increasing volumes of gas will need to be extracted from remote areas.

Biomass: 6%

(renewable) Biomass energy is plant or animal matter than can be converted into fuel. Nearly half the world's population relies on biomass, mostly in the form of wood. Sticks and branches are the principal fuel for 80% of the people in developing countries.

Hydro: <2%

(renewable) Falling water generates one-fourth of the world's electricity.

Solar: <1%

(renewable) Photovoltaic cells can change sunlight into electricity. Yet solar energy is not yet a viable commercial option.

Nuclear: <1%

(nonrenewable) Nuclear power, once hailed as the answer to all the world's energy problems, now supplies little electricity. Concerns with this source include waste disposal, public safety, and high overall costs.

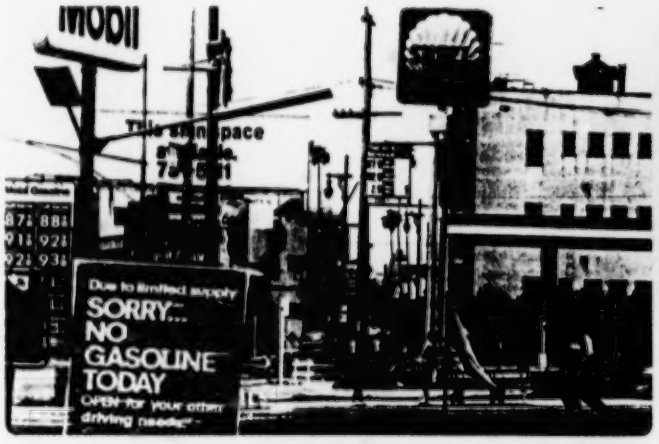
Wind: <1%

(renewable) Winds are caused by uneven heating of the Earth's surface. Windmills generate electricity. California and other areas have installed wind farms to harvest this blowing resource.

Data Source: Chiras, Daniel D. Environmental Science 5th Edition. *Belmont, CA: Wadsworth Publishing, 1998. Additional illustration by Shelly Boggs*

energy conservation. It just isn't that simple. Technology can't always save us from ourselves. While technical solutions will be part of the future, we all have to do our part. We must find ways to reduce our use of natural resources.

In recent years we have been able to reduce our use of fossil fuel by improving the fuel efficiency—miles traveled per gallon of gas—in automobiles. However, these gains have been more then offset by the increase in the number of miles we drive and by recent trends toward using larger, less fuel-efficient vehicles, such as sport utility vehicles.

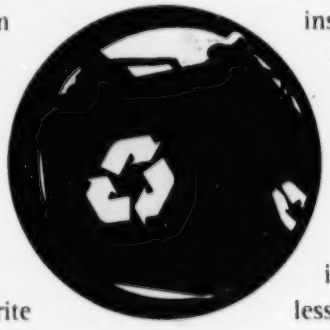


gas embargo

The 1973 oil embargo created a shortage of gasoline across the United States.

Photo credit: Corbis, New York

What does this mean? Again, we must simply use less. We can walk or bike instead of use a car. We can buy products that have a minimum of packaging instead of ones that are wallowing in excess plastic and paper. We can carpool or use public transit instead of driving around by ourselves.



Another way to reduce impacts is to use resources more efficiently. Why not write on both sides of a piece of paper instead of just one? Or take a bus or carpool instead of driving alone to school or work?

Or how about substituting one resource for another? For example, Americans could install more wind generators to reduce our reliance on electricity produced from the burning of fossil fuels or from nuclear reactions. We could use natural gas instead of gasoline to power our vehicles. (Natural gas is found abundantly in the United States and produces less air pollution than gasoline.)

The process of switching to alternative fuels can build on itself. As car manufacturers produce and sell more natural gas and propane vehicles, and as fuel suppliers build more stations and more fleets, consumers will have more chances to use alternative fuels and vehicles. In the longer term, biomass (energy derived from plant materials) and electricity (derived from solar energy) also could become viable alternative fuels.

solar car

Photo credit: University of Michigan, Solar Car Team

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In fact, plant biomass can be fermented to produce alcohol, which is a convenient fuel. Brazil produces much of its own fuel for automobiles in this way. However, there are drawbacks to this method. Large amounts of land are needed to grow the plants (corn, trees, etc.) needed for large scale fuel-alcohol production.

We also can decrease environmental impacts of resource use by using pollution control technology. For example, scrubbers on power plants and catalytic converters on cars reduce air pollution. But even these technologies don't eliminate all pollutants.

Recycling materials can also help to reduce environmental impacts. When we recycle, we reduce the need to extract raw materials. Recycling minimizes pollution and reduces the amount of waste going into landfills. It also takes less resources and energy to make an end product using recycled materials.

"FOR MOST **car-owning households,** A REMARKABLY CONSTANT PROPORTION OF THEIR **spending** GOES TO **motoring**— BETWEEN **13 and 16 per cent** OF THE HOUSEHOLD **budget.** THEY SPEND MORE ONLY ON **housing** AND **food.**"

—JOHN DAWSON
AUTOMOBILE ASSOCIATION OF AMERICA

While newspaper, bottle, and can recycling is commonplace in much of the United States, recycling larger goods, such as automobiles and tires, isn't common. Many believe that about four-fifths of the parts in some cars can be reused. Today, manufacturers are creating car parts that can be disassembled and reused instead of trashed. In the future we may see disassembly sites rather than junkyards.

things to think about

Discuss these questions in small teams or as part of a larger group.

1. Extracting primary metals (e.g., mining iron ore) consumes the greatest amount of energy in the industrial sector. Which activity consumes the greatest amount of energy in the transportation sector? Explain why you think this activity consumes so much energy.
2. What natural resource constitutes the world's largest energy supply?
3. Explain the difference between renewable and nonrenewable energy sources.
4. Name a fossil fuel. Is it considered a renewable or nonrenewable energy source? Why?
5. List six hidden, indirect costs of driving automobiles.
6. Identify two personal actions you could take to conserve energy when you travel.

Federal responses to managing consumption of resources and energy

The following timeline demonstrates how threats to the U.S. energy supply resulted in Federal action:

1973 The Organization of Petroleum Exporting Countries (OPEC) decided to reduce production and increase the price per barrel of oil. Everyone in the United States felt the squeeze of the 1973 oil embargo. The price at the gas pump doubled. There were long lines for limited amounts of gas. The cost of heating oil jumped so dramatically that many people were unable to afford heat. Some people suffered due to lack of heating.

1975 Because motor vehicle transportation accounts for at least half of U.S. petroleum use, officials decided to improve our energy security. They enacted the Energy Policy and Conservation Act of 1975. Each auto manufacturer had to improve the fuel efficiency of its cars to meet specified Corporate Average Fuel Efficiency (CAFE) Standards. Average fuel efficiency in cars and light trucks went from 15.3 miles per gallon (mpg) in 1975 to 25.4 mpg by 1990.

1990 The Gulf War reminded us of how costly our reliance on foreign oil can be. The two-week armed conflict cost $5 billion, and our ongoing military presence in the Middle East costs $50 billion per year to maintain.
Source: Kunstler, James Howard. Home from Nowhere. *New York: Simon & Schuster, 1996.*

1995 The Intermodal Surface Transportation and Efficiency Act (ISTEA) set aside funds for communities to encourage alternatives to individual vehicles. Some funds will be used for more energy efficient public transportation. Other funds will help explore land use designs that reduce the need for individual travel.

1997 World leaders gathered at Kyoto, Japan, to work out strategies for reducing global energy consumption and carbon dioxide emissions. Several agreements were reached to develop new technologies to aid resource conservation practices. Still, many recognized that the challenges are great. Everyone's participation will be needed to bring about significant change.

personal transportation (pta) assessment

activity 2a

notes for instructors

Subjects: Social Science, Math, Earth Science.

Activity Outcomes:
Students should be able to:

- UNDERSTAND THE CONNECTION BETWEEN THE COSTS AND BENEFITS OF TRANSPORTATION MODES AND ENERGY USE;
- ASSESS WEEKLY TRANSPORTATION USE;
- COMPARE TRANSPORTATION ALTERNATIVES, THEIR CONVENIENCE AND ENERGY REQUIREMENTS.

Time Required: 45 to 60 minutes.

Equipment and Materials: Photocopies of activity 2a handouts #1 and #2; chalkboard and chalk or flip chart and markers.

Activity Overview

Participants graphically assess their weekly transportation use by filling out and discussing a Personal Transportation Assessment (PTA). They brainstorm ways to reduce energy use by choosing more efficient transportation.

From Benchmarks for Science Literacy:

What alternative ways are there to achieve the same ends, and how do the alternatives compare to the plan being put forward? Who benefits and who suffers? What are the financial and social costs, do they change over time, and who bears them?

Doing the Activity

Do most people do things out of habit, or because of need? In this activity, students will examine the transportation choices they make every day, and analyze the costs and benefits of their choices.

If you haven't already had students read the Unit Background, let them do it now. After they are finished, discuss the questions from *Things to Think About*, found on page 6, in the large group. (Answers are found in the back of the book.)

Give copies of handouts #1 and #2 to each person. Instruct participants to retrace their transportation paths for the last week and complete the PTAs. (Note: You may wish to divide participants into teams of three or four, and let them fill out the forms by comparing and discussing with other team members.)

After everyone in the group has completed a PTA, compile the total amount of energy used by the entire group and post the results on a chalkboard or flip chart. Use the compiled results to ask students the following:

1) What was the total energy use of the group?

2) Which type of transportation resulted in the most energy being spent? Which was second? Third? (Rank these.)

3) Was there much variation between groups?

4) What was the mean (average) energy use per day?

5) What was the mean energy use per participant per week?

6) What type of fuel was used for walking? Bicycling? Skateboarding?

7) What type of fuel was needed for automobiles? Buses? Motorcycles?

8) Compare and contrast the energy use of a walker, for example, to that of a car with one rider.

Next, help the group brainstorm ways to reduce their energy use by changing transportation habits. You can use a brainstorm burst to do this. Draw a circle on the chalkboard (or flip chart). Write the words "Reduce energy." Then, ask the group to think of ideas to reduce their total energy use related to transportation. They should be specific. Examples include "Taking a school bus instead of driving myself," or "Walking to a neighbor's instead of using an all-terrain vehicle to cross fields."

(Note: You may wish to refer to the *Things to Think About* questions from the Unit Background. Students need to understand what impact reducing use of fossil fuels will have upon the economy and environmental quality. Make sure that students understand the impacts of their decisions, and have some motivation to examine lifestyle changes that may reduce the use of fossil fuels.)

Finally, ask the group: What changes would have to be made to reduce the classroom use by 10 percent? By 20 percent? Are these changes easy to make? How would they affect your lives? Could they reduce use of fossil fuels by reducing the total miles traveled, versus changing the mode of transportation? What are some ideas for doing so?

Checking Progress

Were students able to complete and do calculations for the Personal Transportation Assessment? Did they take part in the discussions? Did they express their personal values? If students were unable to do any of these, what were the impediments? What can be done to remove them?

personal transportation assessment (pta)

activity 2a
handout #1

How to use this worksheet

1. List the trips you made during the last week. Briefly record where you went and why.
2. List the mode, or type, of transportation you used for each trip.
3. List the distance in miles (round trip).
4. Convert this distance to kilometers. To do this, multiply miles by 1.67. For example, 1 mile = 1.67 kilometers.
5. Use the personal energy chart (Activity 2a handout #2) to figure out how many kilocalories per kilometer is used for different transportation activities. Find the best match. For example, it takes about 25 kilocalories for a person to bicycle at four miles per hour for one kilometer.
6. Next, multiply the kilocalories per kilometer by the total amount of kilometers you traveled.
7. Add the daily totals to get a weekly total.

Date	Reason for travel	Mode of transportation	Distance in miles	Conversion to kilometers	Kcals per kilometer (see Activity 2a handout #2)	Total Kcals consumed
Example	home to school	bike	.75	x 1.25	25 Kcals	= 31.25 Kcals
Example	school to soccer	car	5.5	x 9.2	890 Kcals	= 8188 Kcals
Monday						
Tuesday						
Wednesday						
Thursday						
Friday						
Saturday						
Sunday						

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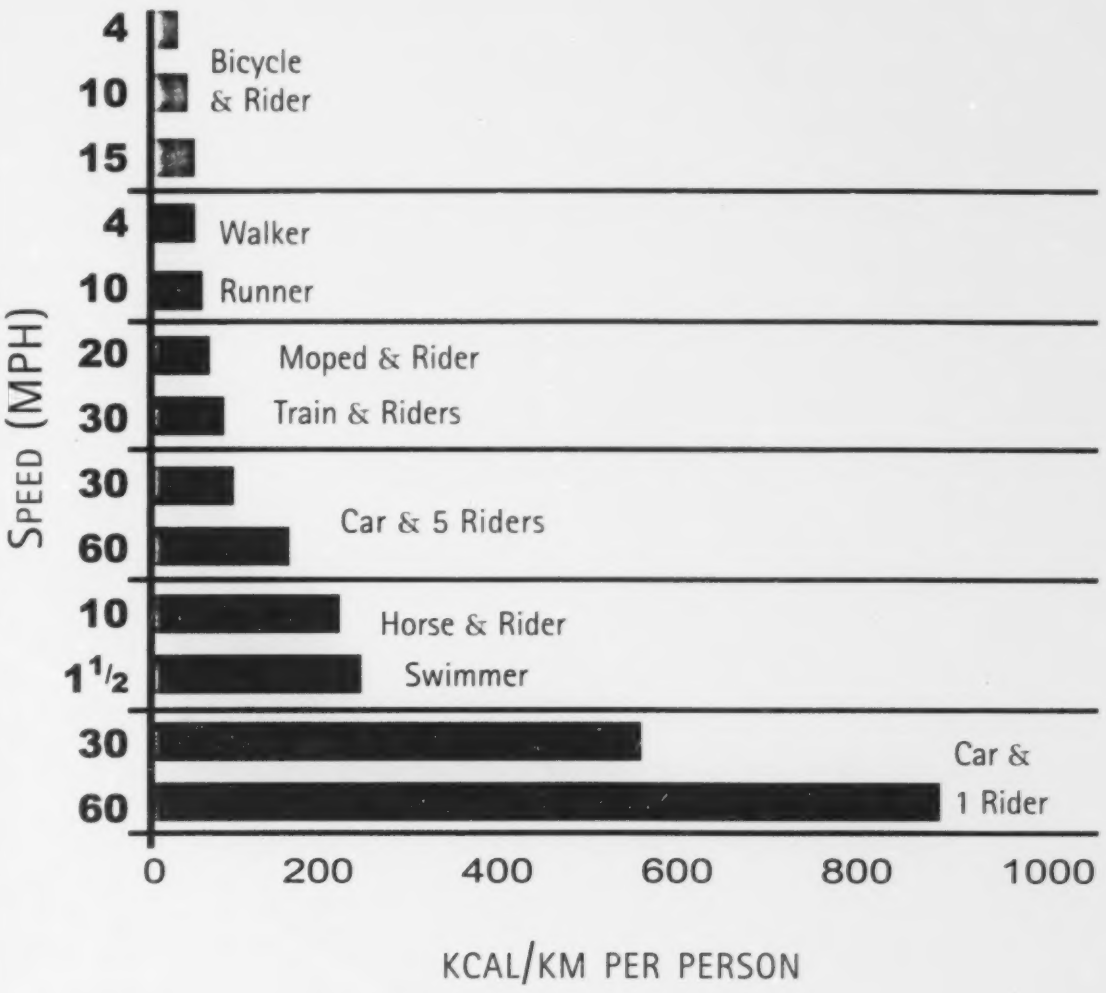
personal energy use

activity 2a
handout #2

How much energy does it take to get where you're going? Look at the chart below.



kilocalorie = amount of energy required to raise the temperature of 1000 grams of H_2O 1 degree C.

walking around

activity 2b

notes for instructors

Subjects: Social Science, Math, Earth Science.

Activity Outcomes:
Students should be able to:

- IDENTIFY A PROBLEM OR DESIGN AN OPPORTUNITY;
- ASK INCISIVE QUESTIONS AND EXPRESS OPINIONS;
- SPEAK AND WRITE PERSUASIVELY;
- TEACH OTHERS;
- CONDUCT SYSTEMATIC INQUIRY;
- LEAD CHANGE WHILE REACHING OUT TO THE COMMUNITY.

Time Required: Varies, depending on data follow-up. Plan on at least two to three hours.

Equipment and Materials: Photocopies of activity 2b handout.

Activity Overview

In the previous activity, participants calculated the amount of energy they used to get around. (Probably, many relied mostly on cars for their transportation.) This activity examines other transportation options, particularly walking, and how youth can improve their community's walkability.

From National Science Education Content Standards

Standard Science and Technology:
Students should be able to identify a problem or design an opportunity.
Students should be able to identify new problems or needs and to change and improve current technological designs.

Doing the Activity

It's a good idea to do Activity 2a first, since students will have probably identified a dependence on cars or other motor vehicles to get around.

You can do this activity in at least two different ways. One is to assign the task to teams of two to three youth to finish independently. Another is to do the activity as a group project outdoors.

If you haven't done so, let students read the Unit Background and, as a group, discuss the questions from *Things to Think About* found on page 6. (Answers are in the back of this book.)

Give students copies of activity 2b handout. Explain that they will (either in teams or as

a group) assess walking as a viable means of travel within their communities. As independent teams, they will choose the walking area they want to evaluate and complete the task. As a larger group, you will select the walking area that will be assessed and help students complete the activity together. Follow the directions on the handout to make the assessment.

If you choose to complete this activity using teams working independently, ask that they inform you of the areas they wish to evaluate. You may want to specify that an adult accompany them, for safety reasons, if the area isn't conducive to walking.

After the walking area is evaluated, ask teams to present their findings. If applicable, draw a map showing the areas evaluated as part of the community. What inferences can be made about the walkability of the community?

Ask students the following questions:

- Why do you think it's so (easy, hard) to walk in this area?
- Why do you think walking (is, isn't) supported with more tax dollars and infrastructure?
- Do you think other forms of transportation, such as busing, bicycling, and trains are well supported in this community? (If you were to give a grade, what would it be?)
- Do you think people are limited in their choice of transportation here? Why or why not?
- Do you think you would use transportation other than cars if good options existed? How would things have to change for you to use these other options?

PRESENTING FINDINGS TO A LARGER AUDIENCE

How can students communicate their findings to more community members? Here are a few ideas:

- Plan and organize a small walk-a-thon along one of the paths, with an ending mini-rally, to present findings about whether the community is walker-friendly. Invite school personnel, family members, neighbors, and local officials.
- Organize the data and write an article for the school or local newspaper. Present findings, and ask for readers to write the newspaper with their opinions.
- Designate "Friendly for Walkers" areas throughout the community. Resolve to use these areas more and tell others about their existence.
- Attend city or county board meetings to present data. Urge officials to take a specific action, such as installing a walking path or crosswalk.

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- PLAN SHORT SKITS TO TEACH YOUNGER CHILDREN ABOUT WALKING SAFELY IN THE COMMUNITY.

Checking Progress

Collect the walking surveys to assess how thoroughly they were completed. Did students identify issues and ask incisive questions on the forms? Did they identify new problems?

Optional Ideas

Students can assess a given area in their community for other transportation options, such as bicycling or busing. Assign teams the task of designing their own surveys, using Activity 2b handout for reference. They can then implement the survey and present their findings to the larger group or follow other suggestions found in this activity for presenting their data.

can you get around in town?

activity 2b
handout

Take a walk with a team member or as part of a larger group. As you walk, use this checklist to decide if your area is a safe and friendly place to walk. Choose a route you usually travel by car or bus, such as to school or to a local store.

When asked to assign a number, use this scale:

1 terrible
2 still not good
3 not bad, not good
4 good
5 very good

Location of your walk _____

1. Was there a specially-designated walking path or trail for the entire distance of your walk? If yes, check here: ☐

2. What were the sidewalks like? Check the ones below where you can answer "yes."

_____ Was there enough room to walk?

_____ Were there sidewalks the entire way?

_____ Were the sidewalks in good condition (no missing chunks, large cracks, etc.)?

_____ Were the sidewalks unobstructed (not blocked with poles, signs, etc.)?

_____ Were there enough footpaths and sidewalks to make the walk safe?

Rate the overall condition of the sidewalks from 1 to 5 _____

Write down some of the worst problems, if any _____

_____

3. How reasonable was the traffic? Check the ones where you can answer "yes."

_____ The traffic yielded to people crossing the street.

_____ The traffic was light enough so that noise wasn't a problem.

_____ The traffic moved efficiently and safely down the street.

Rate the overall traffic conditions from 1 to 5 _____

Write down some of the worst problems, if any _____

_____

4. Was it easy to cross the streets? Check the ones below where you can answer yes.

_____ The road was narrow enough to make crossing safe.

_____ The traffic signals gave us enough time to cross.

_____ Nothing, such as parked cars or trees, blocked our view of the crossing.

Rate the overall traffic conditions from 1 to 5 _____

Write down some of the worst problems, if any _____

_____

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5. Was your walk fun and safe? Check the ones below where you can answer yes.

_____ The streets were clean and free of litter.

_____ Any dog or other animal messes were cleaned up.

_____ Trees, plants, and other scenery was pleasant.

_____ Other users were nonthreatening.

Rate the overall fun and safety conditions from 1 to 5 _____

Write down some of the worst problems, if any _____

_____

Now score your answer. Each check mark is worth one point. Add them to the other numerical ratings to determine your score.

30 -36	Your community is the perfect place for a walk!
23 - 29	Your area could use a little help in making walking easier for people to do.
16 - 22	It's getting iffy at this point. Your community needs to find ways to improve safety so walking can be a transportation option.
9 - 16	Not good. Your area needs to do some serious work to begin to address their lack of usable trails.
Under 9	Look around you. There's a good reason why you never see anyone out walking. There aren't any trails or paths to support this activity.

answers

from page 6

things to think about

Answer #1: Highway vehicles consume the greatest amount of energy (74 percent). People drive many miles on American highways.

Answer #2: Oil (40 percent) is the world's largest energy supply.

Answer #3: Nonrenewable natural resources include minerals (such as aluminum, tin, and copper) and energy-producing fossil fuels (such as coal, oil, and natural gas). These natural resources are present in limited quantities and are depleted by use. They can't be replenished by natural processes within a reasonable time period. For example, fossil fuels, which are the remnants of prehistoric organisms, take millions of years to form.

Renewable natural resources include trees in forests, fish in lakes, etc. Renewable natural energy sources include hydropower, biomass, geothermal wind, and solar energy. Nature replenishes these resources as long as they are not overexploited.

Answer #4: Oil, natural gas, or coal all are fossil fuels. No, these sources are not renewable (see Question #3).

Answer #5: Hidden or indirect costs of automobile use include many things. Here is a list. Accidental and health care. Road construction and maintenance. Land use for automobiles (parking lots, gas stations, driveways). National security for foreign oil reserves. Depletion of upper atmospheric ozone from car air conditioners. Creation of air pollution from cars. Scenic loss from air pollution. Traffic congestion. Disposal of tires and cars in landfills. Climate change. Cost of resource depletion for metals in manufacturing process.

Answer #6: To minimize energy use, you could carpool, use a bicycle, ride a bus or train, or walk. Or, you could modify your driving habits, including minimizing braking, not idling your engine for more than a minute, keeping your car well tuned, and keeping tire pressure at specified levels.

GAS

GAS

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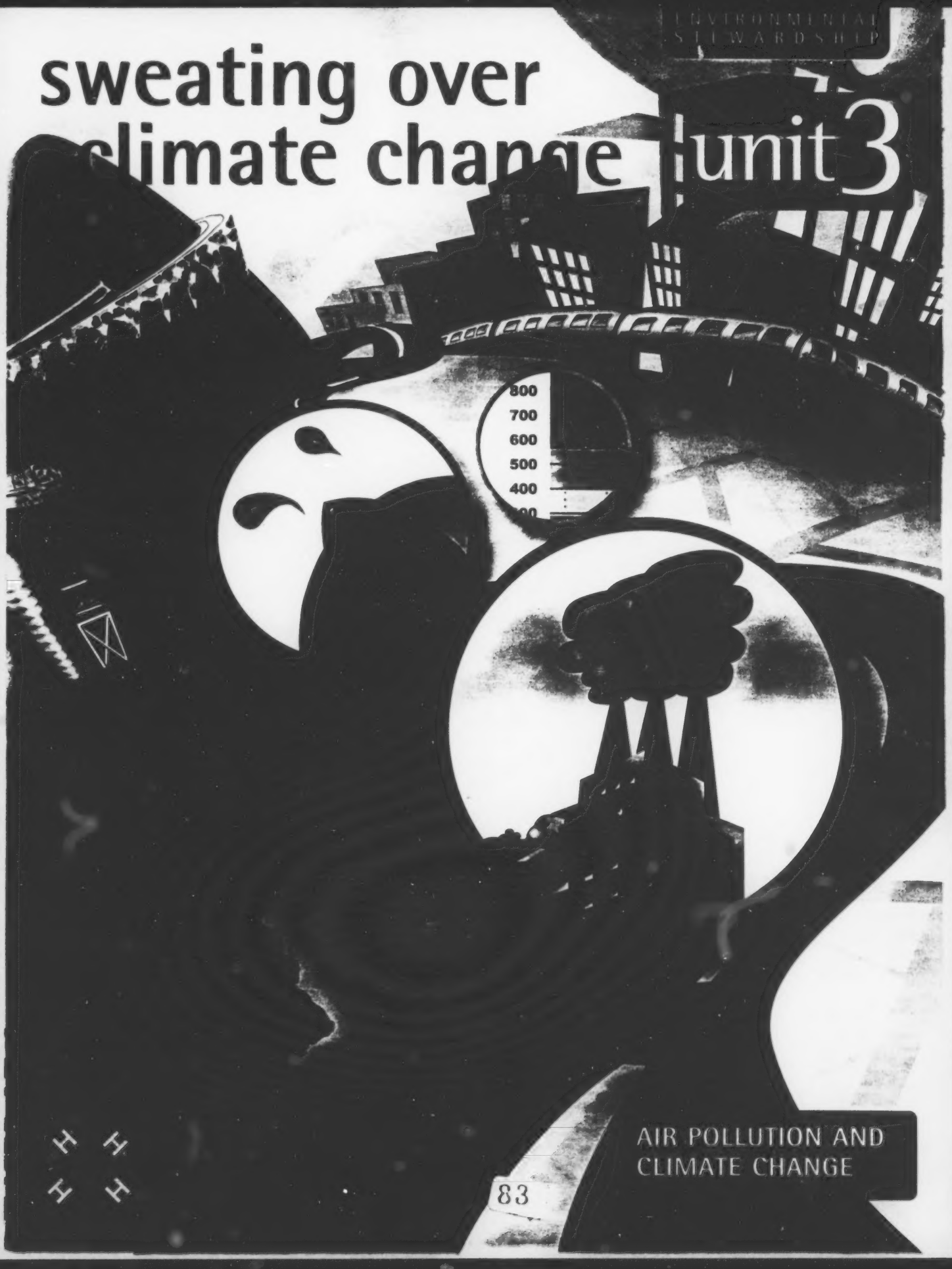
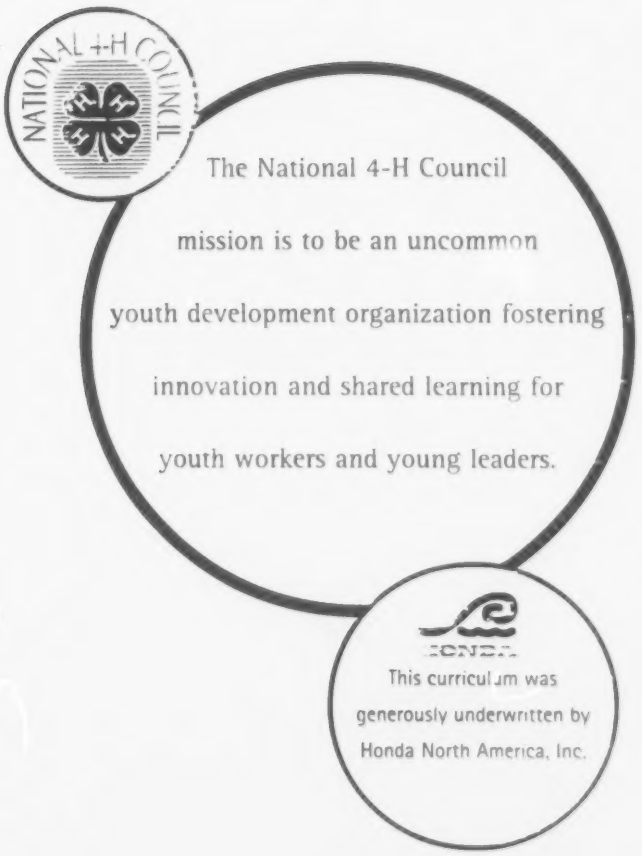
ENVIRONMENTAL STEWARDSHIP

sweating over climate change

unit 3



AIR POLLUTION AND CLIMATE CHANGE



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unit 3

sweating over climate change

AIR POLLUTION AND CLIMATE CHANGE

EMBARK ON A **new** LEARNING **adventure!**

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

'85

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GOING PLACES, MAKING CHOICES
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Website Resources

The websites listed here will give students access to ideas and information. Please note these addresses can change. Students can use keywords such as climate change, air pollution, ozone, and greenhouse gases to search the Internet and find other sites. Let them explore!

- GOING PLACES, MAKING CHOICES
  www.fourhcouncil.edu/ycc/gpmc/index.html
- NATIONAL CLIMATIC DATA CENTER, NOAA
  www.ncdc.noaa.gov
- WORLD METEOROLOGICAL ORGANIZATION
  www.wmo.ch/web/etr/etrp97.html
- AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
  www.aaas.org
- TOPOGRAPHIC MAPS—FERMI LABORATORIES
  fermi.jhuapl.edu/states/states.html
- NATIONAL GEOPHYSICAL DATA CENTER
  www.ngdc.noaa.gov
- EPA'S TRANSPORTATION AIR QUALITY CENTER (TRAQ CENTER)
  www.epa.gov/oms/traq
- PEW CENTER ON GLOBAL CLIMATE CHANGE
  www.pewclimate.org
- INTERNATIONAL ENERGY AGENCY
  www.iea.org/climat.htm

sweating over climate change

unit 3

TOURGUIDE NOTES

Unit Destination

In Unit 3 students will examine how our atmosphere is affected by human activity. The air we breathe can be polluted by human actions. We can even change the earth's climate. Transportation affects both aspects of our atmosphere.

Although much of this subject of global climatic change is still controversial, most scientists agree that our climate is heating up. What isn't so clear is how much of this warming is due to natural phenomena and how much is due to human impacts.

Learning Objectives

Students will:

- EXPLAIN WHY GLOBAL WARMING, OZONE DEPLETION, AND AIR POLLUTION ARE SERIOUS ENVIRONMENTAL THREATS;
- LIST EXAMPLES OF AIR POLLUTANTS AND GREENHOUSE GASES;
- COMPARE PAST AND PRESENT CLIMATE AND EMISSION DATA AND PROJECT FUTURE TRENDS;
- ANTICIPATE HOW THINGS MAY CHANGE IN THEIR LIFETIMES AND ANALYZE WHAT ACTIONS MIGHT BE TAKEN TO ALTER THE CURRENT PROJECTIONS.

UNIT BACKGROUND

Many human activities, including driving cars, harm the air around us. When we pollute the atmosphere, we compromise our health. We also can harm other living things. Recently, we've discovered how adding gases to the atmosphere causes two larger and more far-reaching problems–ozone depletion and global climate change.

What Is Air Pollution?

What makes up the air we breathe? Normally, it consists of nitrogen (78 percent) followed by oxygen (21 percent) and argon (about 1 percent). The troposphere (the part we breathe) also contains about .03 percent carbon dioxide and harbors traces of neon, helium, krypton, and xenon, along with water vapor.

Today, you'd have to add other substances to that mix of things we breathe. These things are air pollution. Air pollution is released into the atmosphere, altering it in ways that have a negative impact on human health. Carbon monoxide (CO), nitrogen oxides (NO, NO_2), ozone (O_3), sulfur dioxide (SO_2), volatile organic compounds, dust, and even metals can be found brewing in the blue skies overhead.

Most air pollution comes from industrial smokestacks and motor vehicles. We also get it from burning fossil fuels or wood in our homes and from road and agricultural dust.

Air pollution causes health problems, whether you can see it or not. In some U.S. cities, air pollution has increased lung-

top 10 smoggiest areas in the U.S.

Source: The World Almanac 1999. *Mahway, New Jersey: World Almanac Books.*

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related diseases among children. Smog (ground level ozone) can cause burning in the eyes and nose. It can irritate your throat and make it hard to breathe. Some chemicals found in polluted air can cause cancer, birth defects, and brain and nerve damage, as well as long-term injury to the lungs.

Air pollution also can damage the environment. Some air pollutants (sulfur dioxide and some nitrogen oxide gases) cause acid rain. This can make lakes too acidic to support the living things that normally dwell in them. Acid rain can harm trees, buildings, and monuments. Other pollutants can cause haze that reduces visibility. If severe enough, they can even keep airplanes from flying!

Some major air pollutants are shown in the chart on page 4.

Motor Vehicles and Air Pollution

Motor vehicles pollute the air in several ways:

- HYDROCARBONS ARE COMPOUNDS MADE UP ONLY OF OXYGEN AND HYDROGEN. THEY EVAPORATE FROM UNBURNED GASOLINE IN THE VEHICLE AND WHEN IT'S REFUELED.
- FINE ROAD DUST IS LIFTED INTO THE ATMOSPHERE AS VEHICLES MOVE ALONG THE ROADWAY.
- DIESEL TRUCKS EMIT FINE PARTICLES.
- HYDROCARBONS, OXIDES OF NITROGEN, CARBON MONOXIDE (CO), AND OTHER GASES ARE RELEASED THROUGH THE TAILPIPE.

Federal and state laws and regulations have helped reduce automobile pollution. The Clean Air Act required states to consider air quality concerns when planning transportation.

it's a fact

AN IMPORTANT DIFFERENCE

FOSSIL FUELS EMIT **carbon monoxide** (CO) WHEN BURNED. CARBON DIOXIDE (CO_2) IS **exhaled** BY ANIMALS AND ABSORBED BY PLANTS. CO IS FOUND IN **air pollution**. CO_2 CONTRIBUTES TO GLOBAL **climatic change**, SINCE IT'S A GREENHOUSE GAS.

Manufacturers must equip cars with catalytic converters and other pollution control devices. Cars and gasoline fueling nozzles have devices that control fumes. Gasoline for sale in the United States no longer contains lead. Also, oil refiners are required to reduce other fuel constituents that pollute the air, such as sulfur and hydrocarbons. Today, well-maintained cars put out about 60 to 80 percent less smog-generating pollution than cars did in the 1960s.

While we're working to reduce air pollution from transportation, we've been increasing the amount of travel we do, often offsetting any gains. Simply put, we're driving more. Think about it. When you need to get a snack, do you walk to a fast-food place? Or do you try to find a ride in an automobile? If you need to get home from basketball practice, do you ride a bike? Or do you call for someone to pick you up? It all adds up.

And it adds up big. It's been estimated that we're now traveling some four trillion miles each year in motor vehicles, compared to one trillion in 1970. We're also using more sport utility vehicles, minivans, and light-duty trucks. The emissions standard for

these vehicles is less stringent than for passenger vehicles. If these trends continue, we'll lose the environmental gains we've achieved by requiring cleaner vehicles and cleaner fuels.

Global Climate Change

When our vehicles burn (or combust) fossil fuels, they produce gases that can harm human health. But fuel combustion also increases the amount of carbon dioxide in the atmosphere.

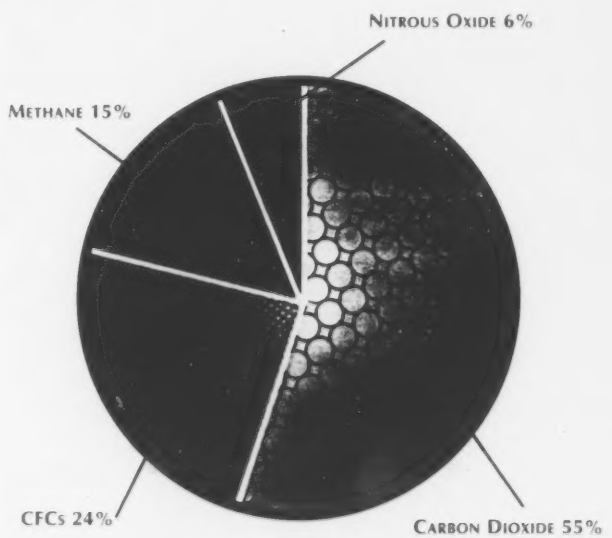
Why is that so bad? Isn't carbon dioxide part of the atmosphere anyway? Well—yes, it is. But as it, and other greenhouse gases (such as methane and nitrous oxide) build, things get out of whack. These gases trap heat so that the earth warms as if it were in a giant greenhouse. These greenhouse gases allow the sun's energy to penetrate the atmosphere to the earth's surface, but do not allow as much of it to escape as heat. Most climate scientists believe that this is causing more heat to be trapped near the earth. They believe this heat is altering air temperature and movement, causing changes in weather and climate.

A recent consensus of some 2,500 well-respected scientists confirmed that human-generated greenhouse gases are, in fact, building up in the atmosphere and will likely increase the earth's temperature by 2 to 6°F. Think of it. If your temperature went up over 6° to 104.9, you'd probably be in the hospital! Some scientists believe this earthly fever is enough to raise ocean levels. This means tremendous flooding for some coastal areas.

The change in global climate from this heating could affect human and animal health, agriculture, tree growth, water availability, and species survival. Animals might be forced to migrate as weather patterns change. Humans also might find their communities radically changed and some even uninhabitable due to climate volatility.

Contributors to Climate Change

Whenever we burn fossil fuels or wood, we make greenhouse gases, primarily carbon dioxide. Electricity-generating plants, furnaces, appliances, and even lawn mowers give off carbon dioxide. However,



Source: The New State Of The Earth Atlas, 2nd Edition, by Joni Seager

greenhouse gases

Although we often blame industry for the increases in pollution, our driving is actually the biggest contributor to increased greenhouse gases.

Seager, Joni. *The New State of the Earth Atlas*, 2nd Edition. New York: Simon and Schuster, 1995.

transportation is a major contributor because cars, trucks, motorboats, and airplanes use fossil fuels. Transportation is expected to be the main culprit for growth in carbon dioxide emissions in the near future. The United States will be one of the major contributors to the problem.

The amount of carbon dioxide produced depends on the amount of fuel burned. So increasing the fuel efficiency of vehicles will help reduce the problem. Most major automobile companies have tried to help increase fuel efficiency.

However, remember, these gains are offset by two trends. The first is an increase in the number of miles driven. The second is a drop in average fuel efficiency since the late 1980s, due to a rising interest in driving bigger, less efficient vehicles such as sport utility vehicles.

These trends provide some valuable ideas as to how we can reduce carbon dioxide emissions. Other places to look for emission reductions include:

- POWER PLANTS THAT BURN FOSSIL FUELS;
- RESIDENTIAL ENERGY USAGE;
- COMMERCIAL HEATING AND AIR CONDITIONING.

In the United States, addressing global climate change concerns is largely voluntary. International negotiations are changing this. Meanwhile, voluntary programs are increasing action related to the effect of our use of automobiles on global climate change.

The Ozone Layer

How can a substance that pollutes also protect the earth? Ozone functions differently in the troposphere, where we breathe air, than in the stratosphere, higher up. In the stratosphere, "good" ozone wraps the earth like a blanket. It shields us from the sun's dangerous ultraviolet rays. If the ozone layer disappeared, the earth's surface would become largely uninhabitable.

Worldwide levels of "good" ozone have been dropping for several decades. We lost ozone during the 1980s three times as fast as during the 1970s. By the mid-1980s, scientists found a large hole in the ozone layer over Antarctica. They since have detected a smaller hole over the Arctic. Ultraviolet rays flood unfiltered through these holes.

The primary culprits causing ozone loss are a group of compounds called chlorofluoro-

Ozone: Good and Bad

Ozone exists both in the upper level of the atmosphere (the stratosphere) and in the troposphere, where we humans hang out. It is a pungent, bluish gas.

Stratospheric Ozone is considered "good" ozone. It protects us from dangerous ultraviolet rays. This is the ozone that is being destroyed by CFCs and other air pollutants.

Tropospheric Ozone is "bad" ozone. It's formed when volatile organic compounds and nitrogen oxides are "cooked" in the heat of the sun. "Bad" ozone is generated by human activity, including automobile use.

principal pollutants in the Clean Air Act

CARBON MONOXIDE (CO): Motor vehicles contribute more than 50 percent of carbon monoxide pollution in the United States. CO hampers the body's ability to transport oxygen to organs and tissues.

NITROGEN OXIDES (NO, NO_2): NO and NO_2 contribute to acid rain and smog (ozone formation). They can irritate the lungs, cause asthma and coughing, sting eyes, and harm plants.

SMOG (TROPOSPHERIC OZONE): Ozone in the lower atmosphere is produced when NO reacts with volatile organic compounds (VOCs) in the sunlight. It can cause damage to tissues and cells, cause respiratory problems, and harm plants. You can't always see smog, but it's still damaging.

VOLATILE ORGANIC COMPOUNDS (VOC): Almost 30 percent of VOC emissions in the United States comes from motor vehicles. The rest comes from stationary air pollution sources (factories, dry cleaners, power plants, etc.). VOCs contribute to ozone formation. They are linked with cancer.

PARTICULATE MATTER (DUST, SOOT, AND SMOKE): This pollutant frequently enters the air as a result of road dust and gravel pulverized by traffic. It also can enter the air in wood smoke and when coal is burned in power plants. Larger particles reduce visibility and cause regional haze; the ones too small to see cause lung damage.

SULFUR DIOXIDE (SO_2): SO_2 is emitted from industrial sources, such as coal-fired power plants. It is a main contributor to acid rain. Sulfur dioxide gas becomes particulate matter when converted to sulfate in the atmosphere. Health effects include breathing problems and respiratory illness. People with asthma and chronic lung disease are most sensitive to SO_2.

LEAD: Lead is no longer found in gasoline in the United States and Canada. It can cause circulatory, nerve, and reproductive damage.

carbons (CFCs). Until recently, CFCs were frequently used as propellants for aerosol cans. They also were used as coolants in air conditioners and refrigerators, and to make foam for insulation and packaging. CFCs from car air-conditioning systems are the biggest single source of ozone-destroying chemicals.

One molecule of CFC can destroy more than 100,000 molecules of stratospheric ozone. Other compounds that attack ozone include halons (found in many fire extinguishers), methyl bromide (used as a fumigant in agriculture), and methyl chloroform (used to degrease metals).

Effects of Ozone Depletion

Depletion of the ozone layer allows more ultraviolet radiation to reach the surface of the earth. Ultraviolet radiation is linked to many health problems in humans, including cataracts, skin cancer, and weakened immunity.

Increases in ultraviolet radiation also could cause crop damage. It could disrupt ecological processes such as the production of phytoplankton, an important food for sea life. Some studies relate the decline of worldwide frog populations to increased radiation due to ozone depletion in the upper atmosphere.

The Clean Air Act phased out production of CFCs. It required CFC recycling and labeling of products containing ozone-destroying chemicals. It also encouraged development of "ozone friendly" substitutes. Industry has developed new compounds to replace those phased out.

Discuss these questions in small teams or as part of a larger group.

1. Which pollutes the air the most?
   A. Power plants
   B. Passenger cars and trucks
   C. City buses
   D. Airplanes

2. What does the Clean Air Act require manufacturers to do?

   _____

   _____

3. Why are people so worried about the greenhouse effect?

   _____

   _____

4. By how many degrees is global temperature projected to rise in the next century?

   A. 1 to 3° Fahrenheit
   B. 2 to 6° Fahrenheit
   C. 10 to 15° Fahrenheit

5. List at least three impacts of global warming.

   1. _____
   2. _____
   3. _____

6. What factors have led to the increase of CO_2 emissions?

   _____

   _____

7. What human health concerns are related to the depletion of stratospheric ozone (the ozone hole)?

   _____

   _____

simulating the greenhouse effect

activity 3a

notes for instructors

Subjects: Math, Earth Science.

Activity Outcomes:
Students should be able to:

- INVESTIGATE PHENOMENA OF THE GREENHOUSE EFFECT;
- COLLECT AND INTERPRET DATA.

Time Required: One hour.

Equipment and Materials: Photocopies of Activity 3a directions and Activity 3a handout. For each team: 2 large plastic soda pop bottles with caps, scissors, thermometers, duct and cellophane tape, graph paper, and 2 lamps with high wattage bulbs.

Special Notes: This activity can be done by individual students instead of teams.

Activity Overview

Students conduct an experiment to investigate greenhouse gases.

They build models to mimic the actual atmospheric process involved in the warming of the earth.

From Benchmarks for Science Literacy:

Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

Doing the Activity

To start the activity, make sure that participants have read the Unit Background found on page 2. They also should read and discuss the questions found in *Things to Think About*. (Answers can be found in the back of this book.) They can do this in small teams or as part of a larger group. Optionally, let students read this background and answer questions in teams after they have started the experiment. This will keep teams occupied while collecting data. They will need to break every five minutes to record data.

Divide the group into teams of three to four each. Hand out copies of Activity 3a data sheet. Explain that they will conduct an experiment to investigate the earth's greenhouse effect. Ask teams to state a question that their experiments will attempt to answer. They next will hypothesize what they think the outcome will be and why.

activity 3a

They'll need to document their findings to support or refute their hypotheses.

Note: You may wish to help students think through their research questions and hypotheses. The research question is "which bottle will heat faster?" Their hypotheses will vary.

Give each team photocopies of Activity 3a directions and Activity 3a handout. The first sheet contains the directions to set up and execute their experiments. The second one should be used by teams to record data. Hand out other supplies, including two bottles, two thermometers, duct tape, cellophane tape, lamps with bulbs, graph paper, and scissors, to each team. Give them time to set up and execute their experiments.

Teams should create graphs of time (in five-minute intervals) versus temperature for their observation on graph paper. Have each team present its research question, hypothesis, and findings to the class. Other members should critique data collection and inferences.

Some questions for discussion include:

- Which bottle represents an earth atmospheric system when it is functioning properly? Why? (The bottle with the slits, since it has a mechanism for releasing heat.)

- What do the bottle without slits and the earth (with building greenhouse gases) have in common? (Both trap heat, resulting potentially in surface warming.)

- What does the bottle with vents have in common with the earth? (Radiant energy flows from the earth into space unless trapped, similar to how the heat from the light bulb flows out of the bottle.)

- What do we mean by the greenhouse effect? (It is called that by term because it is analogous to what happens in a greenhouse on a sunny day. Glass lets in short-wave solar radiation. But it prevents long-wave radiation from escaping and inhibits physical contact of the heated inside air with the cooler air outside, so the temperature in the greenhouse rises. Similarly, greenhouse gases trap and reemit long-wave radiation back to the earth, causing it to warm.)

- If the climate warms in one place, does that automatically mean it will become warm everywhere? (No! It's important that students understand national or even international numbers often have no bearing on local conditions. Students could access regional data to figure out what is reality in their area. State and local transportation and air quality agencies should have this data.)

- In your opinion, is global warming a natural occurrence or is it the result

OF THE ACTIVITIES OF PEOPLE? (FROM HISTORICAL RECORDS, WE KNOW WITH A HIGH DEGREE OF CERTAINTY THAT THE EARTH'S TEMPERATURE HAS FLUCTUATED OVER TIME. WHETHER THE CURRENT GLOBAL WARMING IS PART OF A NATURAL CYCLE, OR INDUCED BY HUMAN ACTIVITY, IS STILL DEBATED, ALTHOUGH CONSIDERED A LIKLIHOOD BY MOST CLIMATE SCIENTISTS.

- DESCRIBE AS MANY ACTIONS AS POSSIBLE THAT CAN BE TAKEN TO DECREASE AIR POLLUTION AND TO SLOW GLOBAL WARMING. (DID YOU KNOW . . .WASHING CLOTHES IN COLD WATER INSTEAD OF HOT OR WARM SAVES ABOUT 500 POUNDS OF CARBON DIOXIDE EMISSIONS PER PERSON EACH YEAR? SAVING ONE GALLON OF GAS SAVES 20 POUNDS OF CARBON DIOXIDE EMISSIONS? OTHER SAVINGS INFORMATION IS AVAILABLE THROUGH THE ENVIRONMENTAL DEFENSE FUND, AT WWW.EDF.ORG.)

CHECKING PROGRESS

Could students formulate research questions? Did they pose hypotheses? Were they able to successfully build their models? Were their data collection error-free? Did they manage the resources they had to come to a conclusion? Did they critique others findings?

OPTIONAL IDEAS

Let students review the information on page 11 about How to Be Resourceful. To be successful in life, they don't have to know everything. They can't! They just have to know how to find the answer to lots of questions. The Internet is opening a whole new world of information, but sometimes it feels like a flood, instead of a river that can be navigated. How do students find the best sources of information? Where do they go for the most accurate, non-biased information? How do they quickly pinpoint the most useful resources for projects? Make copies of the following page for students, and discuss whether this list accurately reflects how they conducted their last research project.

activity 3a

how to be resourceful

1. Identify exactly what information you need or want.

2. Determine possible sources of information—universities, government agencies, community members, libraries, etc. You may have to start out with some good guesses about where information might be lurking.

3. Write, e-mail, or search the Internet for the subject title or source names you seek.

4. Write a list of all possible sources and review it.

5. Be creative. Think of places that others might not.

6. Go to at least five sources for your information. Compare and contrast information from these sources. Were they a result of scientific research or speculation? Do they project change in ranges or suggest only fixed outcomes? Were they created by special interest groups? Are some of the sources potentially biased? Can you identify and give examples of bias?

7. Collect all the information and then lay it out for review. Sort and toss what isn't relevant.

8. Keep the information organized! Make files for each set of information from different sources or classify by subject matter.

9. Don't give up! Many people don't persevere and give up before finding what they want.

constructing a model greenhouse

activity 3a
directions

Use clear plastic bottles for this experiment. Follow the directions below:

1. Remove the label of a bottle by soaking it in warm water. Use scissors to cut the bottle apart about three inches above the bottom. Save the bottom.
2. Repeat for another bottle.
3. Cut two or three long vents (1 x 6 inches) in the sides of one of the bottles. (These vents make the greenhouse "leaky" to allow heat to escape.) Leave the second bottle intact.
4. Use cellophane tape to place a thermometer onto the inside of each bottle. Make sure it can be read from outside the bottle, and that it is sitting higher than the base. It's important that the two thermometers are reading the same temperature before beginning the experiment. If they are not, record the difference when the observations are made.
5. Cap both bottles. Seal the plastic bottles back to their bases using duct tape.
6. Place both bottles about six inches away from a lamp with a high-wattage bulb or in a sunny window. Make sure the thermometers are facing away from the light.
7. Turn on the light and record the temperature in both bottles every five minutes on Activity 3a handout.
8. Discuss the results.

Steps to a Sound Scientific Process

1. Carefully form and state your research question. A poorly defined question is difficult to answer.
2. Develop a hypothesis (an idea of what will happen and why).
3. Create an experiment and gather data that will support or refute your hypothesis.
4. Keep very thorough and accurate records for each step of the process. By doing so, others can learn from your work, re-creating what you have done.
5. After you have completed your experiment, record and report your findings so that others may learn from your efforts.

constructing a model greenhouse

activity 3a handout

Research Question: _____

_____

_____

Team Hypothesis: _____

_____

_____

Time	Temperature of Bottle with Slits	Temperature of Bottle without Slits
Starting Temperature		
Interval 1*		
Interval 2		
Interval 3		
Interval 4		
Interval 5		
Interval 6		
Interval 7		
Ending Temperature		

* Intervals are five minutes apart.

data and trend forecasting

activity 3b

notes for instructors

Subjects: Math, Earth Science.

Activity Outcomes:
Students should be able to:

- UNDERSTAND THAT DATA FORMS THE BASIS OF SCIENTIFIC INVESTIGATION ON CLIMATE CHANGE AND OTHER ENVIRONMENTAL ISSUES;
- EVALUATE AND INTERPRET DATA TO IDENTIFY AND FORECAST TRENDS;
- BECOME COMFORTABLE WORKING WITH ALL TYPES OF DATA.

Time Required: One to two hours.

Equipment and Materials: Copies of Activity 3b data sheets 1-3 and Activity 3b handout; colored pencils and/or markers, clear acetate sheets, rulers, posterboard, access to library, encyclopedias, or Internet.

Activity Overview

Understanding where to find data and how to interpret it is critical in a world that thrives on scientific observation. Data provides substance to stated beliefs and a foundation for scientific discovery. Students research climatic change and identify sources of data, find patterns, interpret data, make inferences, present data, and support a theory using data.

From National Science Education Content Standards

Standard A-Science as Inquiry: Communicate and defend a scientific argument. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.

Doing the Activity

Scientists have been collecting data for centuries that is being used today for climate change and environmental research. Scientists hope to derive a sense of what people can expect as the temperature rises or falls on earth.

The one thing that is indisputable from the data collected on climate change is that the temperature on earth is rising. In fact, nine

activity 3b

out of the past 12 years are the hottest ever recorded in history. What does this mean to your group? How will it affect their lives? Help students try to figure out the answers to these questions in this activity as they explore global climatic change.

To start the activity, make sure that participants have read the Unit Background found on page 2. They also should read and discuss the questions found in *Things to Think About.* (Answers can be found in the back of this book.) They can do this in small teams or as part of a larger group.

Next, divide participants into four teams. Inform teams that they are scientists investigating climate change. Assign, or let teams pick, a greenhouse gas to investigate as a team, as below:

Team 1 Carbon Dioxide Emissions
Team 2 Sulfur Emissions
Team 3 Nitrogen Emissions
Team 4 CFC Emissions

Give teams their corresponding Activity data sheet. Also hand out copies of Activity 3b handout (to be used to record information). Each team should conduct research, using an encyclopedia or Internet resources, to find out:

- WHAT THE GAS IS;
- THE ORIGINS OF THE EMISSION GAS;
- WHAT ITS HEALTH EFFECTS ARE;
- ITS POTENTIAL IMPACTS ON THE ENVIRONMENT;
- AND WHAT ALTERNATIVES MIGHT BE AVAILABLE TO MINIMIZE ITS EFFECTS.

Teams should record this information on Activity 3b handout.

Next, give teams Activity 3b data sheet #3, which is the average global temperature. Each team also will need pencils, markers, and clear acetate sheets. As part of their research, teams will plot the raw data about their emission gas against the temperature. Teams should first create graphs, plotting the emission data on the y axis and the year on the x axis. They should then similarly construct a temperature graph on clear acetate to overlay their emissions graph (use the same time scale for both graphs).

Ask teams: What are their data showing? They should interpret the data and draw conclusions regarding past, current, and possible future trends. Now ask teams to continue the trend of the curve for their expected lifetimes. Each team should develop a written conclusion about continued emissions and the warming of the earth.

Each team should present its interpretation of the graphs during a class scientific conference. They should conclude with how they believe this scientific information will

affect them personally. Will growing seasons be longer or shorter? Will the hurricane/tornado/dry season be more severe? Will it snow less, causing the ski industry to lose money?

Ask student teams:

- Why are data important? What are some different sources of data?
- Is there an overall trend that can be extrapolated from the class data?
- How much of these interpretations are based on fact? Inference?
- How credible are the data you used? How can you judge the credibility of data from books, the Internet, or other people?
- What happens when data conflict? Who is right? What criteria do you use to judge which conflicting argument is more credible?

Checking Progress

Did students understand the role of data and research in the science of global climatic change? Were they able to evaluate and interpret data? Did they forecast trends and make compelling arguments to defend their positions? Did they work in groups effectively?

Optional Ideas

MATH CHALLENGE!

Numerous gases contribute to global warming, among them chlorofluorocarbons (CFCs). CFCs are released from refrigerators, freezers, automobile air conditioners, and other sources. They not only contribute to greenhouse warming, but also deplete the ozone layer. Fortunately, CFC production is on the decline.

Give all students the CFC chart from Activity 3b data sheet #2. Ask them to:

Part 1: Calculate the percentage increase in CFC production from 1950 to 1988.

Part 2: Calculate the percentage decline from 1988 to 1995.

Part 3: Decide whether they would expect an immediate decrease in ozone depletion in the upper atmosphere and a decrease in global warming as a result of the declines. Explain why or why not.

Part 1: To calculate the increase in CFC production, divide 1950 levels into 1988 levels (1,260,000/42,000 = 30). This means that CFC production was 30 times greater in 1988 than 1950. Then, multiply 30 by 100 to figure out the percentage increase (30 x 100 = 3000% increase).

Part 2: To calculate the decline in CFC production subtract 1995 production from 1989 production levels (1,260,000 - 300,000 = 960,000 tons, a decrease in production).

activity 3b

To calculate the percentage decline, divide the decrease by 1988 production levels then multiply by 100 (960,000/1,260,000 x 100 = 76% decrease).

Part 3: The dramatic decline results from global treaties designed to eliminate CFC production and release. Although the production levels have declined markedly, CFCs are very stable molecules and will stay in the atmosphere for decades. Because of this, ozone depletion and global warming caused by CFCs may persist for many years.

what's all this data for?

activity 3b
data sheet #1

Team 1 Carbon Dioxide (CO_2)

GLOBAL AVERAGE CONCENTRATION

Year	PPMV*	Year	PPMV*
1960	316.8	1977	333.7
1961	317.5	1978	335.3
1962	318.3	1979	336.7
1963	318.8	1980	338.5
1964	N/A	1981	339.8
1965	319.9	1982	341.0
1966	321.2	1983	342.6
1967	322.0	1984	344.3
1968	322.8	1985	345.7
1969	323.9	1986	347.0
1970	325.3	1987	348.8
1971	326.2	1988	351.3
1972	327.3	1989	352.7
1973	329.5	1990	354.0
1974	330.1	1991	355.5
1975	331.0	1992	356.2
1976	332.0	1993 (est)	357.0
		1994 (est)	358.8
		1995 (prel)	360.7

*ppmv = parts per million by volume

Source: Worldwatch Institute

Team 2 World Sulfur Emissions From Fossil Fuel Burning

1950-1994

Year	Sulfur*	Year	Sulfur*
1950	30.1	1981	61.9
1960	46.2	1982	62.1
1970	57.0	1983	63.0
1971	56.9	1984	64.5
1972	58.2	1985	64.2
1973	60.9	1986	65.2
1974	60.9	1987	66.5
1975	56.4	1988	71.2
1976	58.4	1989	71.9
1977	60.1	1990	70.0
1978	61.0	1991	71.1
1979	62.6	1992	70.4
1980	62.9	1993	70.4
		1994	70.7

* Million tons

Source: Worldwatch Institute

what's all this data for?

activity 3b
data sheet #2

Team 3 World Nitrogen Emissions from Fossil Fuel Burning

1950-1994

Year	Nitrogen*	Year	Nitrogen*
1950	6.8	1981	22.1
1960	11.8	1982	22.2
1970	18.1	1983	22.5
1971	18.6	1984	23.3
1972	19.5	1985	23.4
1973	20.6	1986	23.6
1974	20.8	1987	24.3
1975	19.9	1988	27.3
1976	21.0	1989	27.7
1977	20.8	1990	27.7
1978	22.3	1991	28.0
1979	22.4	1992	27.8
1980	22.3	1993	28.0
		1994	28.2

* Million tons

Source: Worldwatch Institute

Team 4 World CFC Production

1950-1995

Year	Total*	Year	Total*
1950	42	1977	880
1955	86	1978	880
1960	150	1979	850
1961	170	1980	880
1962	210	1981	890
1963	250	1982	870
1964	290	1983	950
1965	330	1984	1,050
1966	390	1985	1,090
1967	440	1986	1,130
1968	510	1987	1,250
1969	580	1988	1,260
1970	640	1989	1,150
1971	690	1990	820
1972	790	1991	720
1973	900	1992	630
1974	970	1993	520
1975	860	1994	388
1976	920	1995	300

* Thousand tons

Source: Worldwatch Institute

what's all this data for?

activity 3b
data sheet #3

All Teams Temperature

GLOBAL AVERAGE TEMPERATURE, 1950-1996

Year	Temperature*	Year	Temperature*
1950	14.86	1978	15.05
1955	14.92	1979	15.09
1960	14.98	1980	15.18
1961	15.08	1981	15.29
1962	15.02	1982	15.08
1963	15.02	1983	15.29
1964	14.74	1984	15.11
1965	14.88	1985	15.09
1966	14.95	1986	15.16
1967	14.99	1987	15.27
1968	14.93	1988	15.28
1969	15.05	1989	15.25
1970	15.02	1990	15.39
1971	14.93	1991	15.36
1972	15.00	1992	15.11
1973	15.11	1993	15.14
1974	14.92	1994	15.23
1975	14.92	1995	15.40
1976	14.82	1996 (prel)	15.32
1977	15.11		

* Degrees Celsius

Source: Worldwatch Institute

108

recording data

activity 3b
handout

Emission gas _____

Where it comes from _____

Health impacts _____

_____

_____

Potential environmental impacts _____

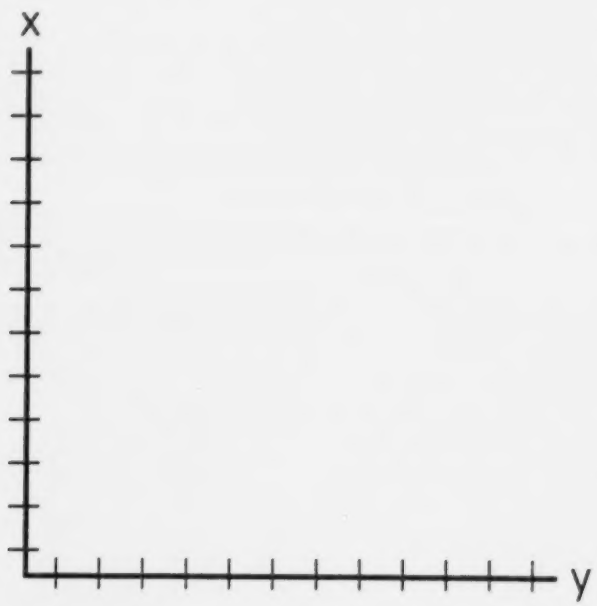
_____

_____

Is there any other alternative for this gas that people could use instead? Explain. _____

_____

_____



Conclusion _____

_____

_____

answers

from page 7

things to think about

Answer #1: B (passenger cars and trucks).

Answer #2: The Clean Air Act requires manufacturers to install pollution control devices called catalytic converters on cars and trucks, along with other devices that control emissions. It also directs manufacturers to remove all lead from gasoline and reduce other fuel constituents, such as sulfurs and hydrocarbons, during the refining process.

Answer #3: The greenhouse effect is produced by the buildup of carbon dioxide and other greenhouse gases (chlorofluorocarbons, methane, and nitrous oxide), which trap the sun's radiation in much the same way that glass traps it in a greenhouse. This causes the earth's temperature to rise, which in turn may cause considerable impacts to ecosystems.

Answer #4: B (2 to 6°).

Answer #5: Impacts of global warming include: Negative human and animal health effects, altered production of food and other agricultural activities, changing weather patterns, and elevation in sea level.

Answer #6: CO_2 emissions have increased because of the rise in demand for energy, an increase in the number of miles driven, less fuel efficient vehicles, and lower crude oil prices (which in turn reduce gasoline prices).

Answer #7: The depletion of stratospheric ozone leads to human health effects that include: eye cataracts, skin cancer, and weakened immunity from sickness and disease.

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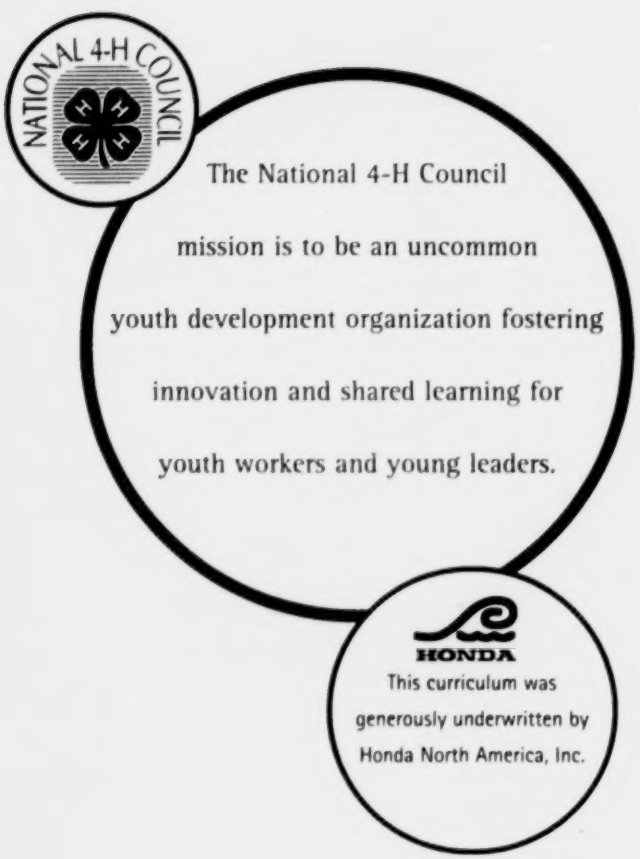
land use

LEAVING OUR IMPRINT ON THE EARTH



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unit 4

LEAVING OUR IMPRINT ON THE EARTH

EMBARK ON A new LEARNING adventure!

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

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LOT FOR
SALE

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GOING PLACES, MAKING CHOICES
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Website Resources

The websites listed here will give students access to ideas and information. Please note these addresses can change. Students can use keywords such as land use, urban planning, and greenways to search the Internet and find other sites. Let them explore!

- GOING PLACES, MAKING CHOICES
  www.fourhcouncil.edu/ycc/gpmc/index.html
- AMERICAN PLANNING ASSOCIATION
  www.planning.org
- CYBURBIA—THE PLANNER'S INTERNET RESOURCE
  www.cyburbia.org
- NATIONAL PARK SERVICE
  www.nps.gov
- AMERICAN FARMLAND TRUST
  www.farmland.org
- NATIONAL RESOURCE INVENTORY
  www.itc.nrcs.usda.gov/nri/nri_indx.htm
- NATURAL RESOURCES CONSERVATION SERVICE
  www.nrcs.usda.gov/
- U.S. DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE STATISTICS SERVICE
  www.usda.gov/nass
- ECONOMIC RESEARCH SERVICE
  www.econ.ag.gov/
- EARTH TRACK FOCUS
  www.nhes.com/current_issue/earthtrack_focus.html

land use

unit 4

LEAVING OUR IMPRINT ON THE EARTH

TOURGUIDE NOTES

Unit Destination

Unit 4 helps learners understand the connection between land use, transportation, environment, and lifestyle. This unit helps students grapple with the issues of creating lifestyles that are sustainable.

History has set the scene for many land use issues we face today. Understanding how we got to our present state is important if we are to solve our future challenges.

Learning Objectives

Students will:

- EXPLORE HOW TRANSPORTATION CHOICES AFFECT LAND USE, LIFESTYLE, AND ENVIRONMENT;
- DETERMINE WHAT IS MEANT BY SUSTAINABILITY;
- LEARN HOW THE LAND USE PROCESS IS CONDUCTED IN COMMUNITIES AND WHO DECIDES HOW LAND IS USED;
- DISCOVER OPTIONS FOR DESIGNING OUR COMMUNITIES.

UNIT BACKGROUND

Land use determines how we live. How we use land affects our quality of life and the quality of our environment. Think of the difference between lifestyles in cities, suburbs, and rural areas. Land use is tied to our evolution as a nation, our population growth, and our pursuit of the American dream. As our population has grown, so has our demand for raw land.

Land Use and Transportation

Throughout history, transportation has been linked with land use. Before railroads were built, waterways were the main inroad into the American frontier. Soon railroads came along and opened up the frontier. Towns and cities sprang up along the railroads in fixed, linear paths. Businesses wanted to be as close to these centers as possible.

During the early 1900s, factories began to get bigger. The demand for larger buildings and more workers grew. Workers required inexpensive housing. Thus were born the booming industrial cities of Chicago, St. Louis, and Pittsburgh, among others.

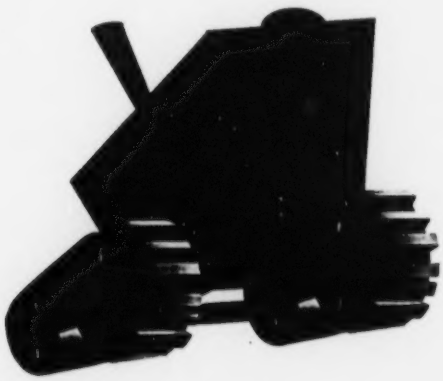
The automobile enriched rural life by making it easier to travel from one place to another. Ironically, it had a very different effect in cities. Automobiles overwhelmed city life with congestion. People began to move away from urban centers, seeking to escape crowds, high-priced living, and pollution.

Until 1950, towns were made for mixed use. Apartments were conveniently located over stores. Walkable streets led from homes to schools, parks, bakeries, and other destinations. Because services were all near each other, horses, trolleys, and bicycles could meet local transportation needs. Trains connected the towns.

Remnants of this setting still exist. However, land use patterns have mostly been transformed by the post-World War II dream for detached single family housing in the suburbs. The push toward the suburbs resulted from:

- THE NEED FOR CHEAPER LAND TO DEVELOP;
- THE DESIRE TO ESCAPE URBAN CROWDS;
- THE DESIRE TO SEPARATE INDUSTRIAL, COMMERCIAL, AND RESIDENTIAL LAND USES;
- THE MOBILITY AND CONVENIENCE PRESENTED BY THE AUTOMOBILE;

consider this:



Americans lose an estimated 2,000 to 2,800 acres of rural land every day to highways, housing developments, shopping malls, airports, and other nonfarm uses. That's 730,000 to 1,020,000 acres a year! If current trends continue, in the next 100 years approximately one-third of America's farmland will be lost to suburbs, malls, and other uses.

Source: Owen, Oliver S., Daniel D. Chiras, and John P. Reganold. Natural Resource Conservation: Management for a Sustainable Future. New Jersey: Prentice-Hall, 1998.

types of pollution resulting from land use

Litter

Easily recognized. Litter is remnants of human activity (cans, paper, plastic bottles, etc.). It's the stuff we leave behind to say "been there, done that." Litter dirties land and waterways, endangers wildlife, and ruins the beauty of open spaces.

Light Pollution

When land is developed for residential or commercial uses, lighting follows. Tall luminescent street lamps, parking lot lights, store lights, etc. are illuminating our skies. That's what makes the stars in city skies so hard to see at night.

Air Pollution

Land uses that create greater distances between destinations contribute to air pollution by increasing miles driven, and therefore fuel use. Generating electricity from fossil fuels and running farms, factories, and homes also contributes to air pollution.

Water Pollution

Pesticides and fertilizers from golf courses, lawns, and farm fields can wash into wetlands, streams, and other waters. Soil from roads and developments enters waterways, altering ecosystems. Sand and salt used to melt ice on winter roadways pollute water and kill trees and other plants along roads. Manufacturing and other human activities can contribute to water pollution. Some pollution can accumulate in fish, making them unsafe to eat. Pollution also kills fish and other aquatic animals.

Industrial Wastes and Chemicals

Chemicals and heavy metals from forest products, petrochemical, mining, textile, and food processing industries can leach from waste disposal sites. Or, they may be discharged into the air and water, creating health hazards.

Noise Pollution

Noise is one of the fastest growing forms of pollution. Finding a perfectly quiet moment is almost impossible for most people in America. Many doctors are now citing noise as a major contributor to human stress. City and country alike put up with noises from cars, airplanes, lawn mowers, trains, horns, and more.

Domestic Wastewater

Sewage, if improperly treated, is one of the biggest pollution factors. It can bring high levels of nitrogen, phosphorous, and bacteria into watersheds, damaging ecosystems.

- ECONOMIC INCENTIVES BY BANKS, GOVERNMENT, AND LENDERS THAT FAVORED SUBURBAN DEVELOPMENT AND DETACHED SINGLE FAMILY HOMES ON LARGE LOTS.

Sprawl City

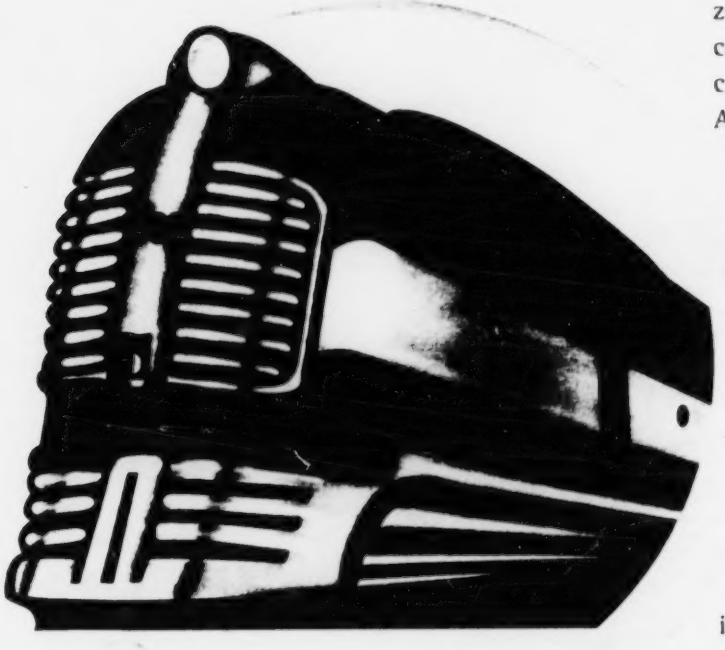
The result is what we now know as suburban sprawl. What does sprawl look like? It's characterized by strip malls and fields filled with single family houses. In a sprawling area, there are miles of roadways and a separation of homes and businesses. There is a diminished sense of place. Sprawl uses more developed land, more pavement, and more resources such as wood and oil for construction and transportation.

In recent years sprawl has taken on a new dimension with the "ruralization" of America. Some people are choosing to move

beyond suburbs into rural areas. They carve homesites and a few acres of personal space from farmland. Developers have capitalized on this trend by installing homes on multiple acres in otherwise rural areas. This tends to alter large segments of land. It also brings housing and agriculture into direct conflict.

Zoning

Land use planning is a complex social issue. Many people oppose government-led planning. They feel it infringes on their personal right to live where and how they wish. But others see it as an important tool for ensuring that the finite amounts of land can meet citizens' diverse and at times conflicting needs.



Trade-Offs Presented by Today's Land Use Practices

EVERY STEP FORWARD CARRIES A PRICE. THE AUTOMOBILE HAS GIVEN US GREATER MOBILITY. YET THE SOCIETAL PRICE INCLUDES:

- SPRAWLING COMMUNITIES HAVE DEVELOPED;
- SOCIETY HAS BEEN CHANGED BY ENCOURAGING RETREAT FROM CULTURALLY DIVERSE CITIES;
- TRAFFIC IS CONGESTED;
- PUBLIC TRANSPORTATION OPTIONS ARE REDUCED, GIVEN LOW POPULATION DENSITIES AND LONG COMMUTE DISTANCES.

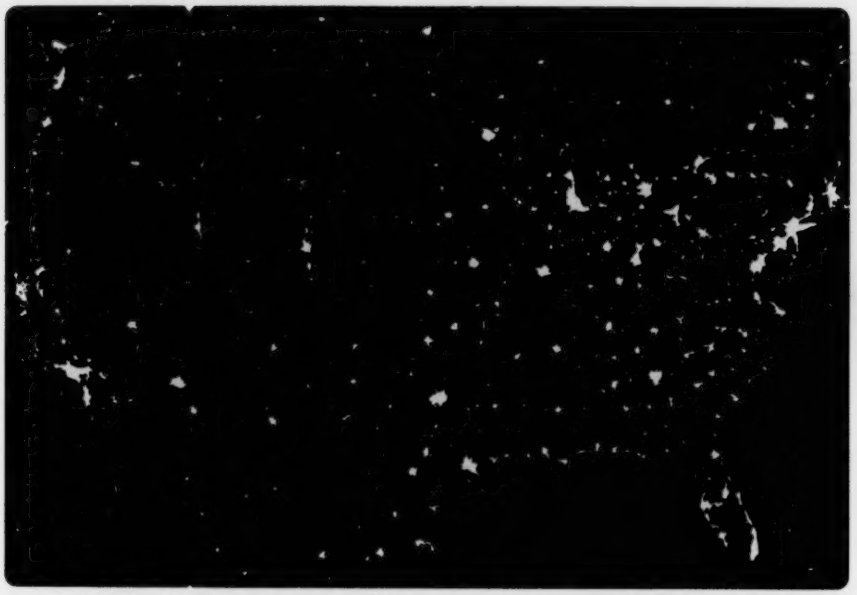
In the United States, land use is governed by zoning laws. These laws are created from a community's comprehensive plan by its citizens, planners, and government officials. A comprehensive plan lays out growth for a community. It considers the area's unique traits, such as environment, growth rates, geography, and economics.

Zoning spells out what uses are permitted on various properties to meet goals in the comprehensive plan. The main purpose of zoning laws is to keep conflicting uses apart. For example, commercial and residential development might be separated. You won't find petroleum refineries right next door to townhouses in most communities.

Why Certain Land Uses Dominate

In recent decades, banks and zoning codes have valued single dwelling homes more

highly than more densely populated dwellings. This has stimulated suburban development. Some laws and tax codes provide financial incentives for detached housing that other forms of housing do not enjoy.



nighttime lights

SOURCE: NATIONAL OCEANIC AND ATMOSPHERE ADMINISTRATION (NOAA)

Land use policies since World War II have encouraged developers to separate residential, commercial, and industrial uses. We now know this adds up to traffic congestion. These policies degrade our quality of life and drive up the cost of infrastructure. They also isolate communities from one another.

Environmental and Social Considerations

The growth of the suburbs has huge social and environmental implications. Suburban communities increase commute distances and driving time. Decentralization creates new traffic patterns and gridlock. Transportation by mass transit or nonmotorized means is difficult. It's hard for those who are too old, young, or poor to drive to get around. This limits opportunities for education and interaction.

Decentralized development increases the demand for fossil fuels. Resources are needed to build more houses, make and run automobiles, construct roads, and so on. Newer suburbs, with their big lawns, recreational facilities, golf courses, etc., are notorious for their water consumption. They also pollute by using excessive fertilizers to keep lawns green.

All new land development requires infrastructure. This infrastructure includes flood control projects, sewer systems, and roads. Flood control projects can change or destroy complex ecosystems. Artificial landscapes, such as ski areas and golf courses, can displace native plants and disrupt wildlife.

We can reduce environmental impacts of this sprawl. Making wise transportation choices and becoming more conscious of wasteful lifestyles are two ways to do so. Increasingly, some land use planners are promoting more compact or "transit-oriented" development. These new patterns protect green, open spaces and native habitat. They reduce reliance on the car and accommodate alternative transportation choices. They return the community to a walkable way of life with a mix of land uses.

Multi-use: Meeting Everyone's Needs

Today more than ever, people compete for land. When land is scarce, a community has

to choose the best uses for available property. For instance, community members might debate whether to use undeveloped land for a park or a hotel. To decide what to do, they consider community needs, public opinion, economics, the environment, and so on. In many towns, land use planning is debated by special planning boards.

A debate is currently brewing over the use of federally owned public lands such as national parks and forests. People use these areas more than ever. But this increased use brings serious traffic and erosion problems. We may, in fact, be "loving" these areas to death.

How to best use land includes debates not only on the volume of use, but the variety. For instance, hikers and backpackers want the quiet and solitude of the great outdoors. Snowmobilers or motor-bikers prefer to use the rustic trails for thrills. One sport requires silence; the other makes noise. Can they coexist? If not, who should prevail? Government agencies, state and federal legislatures, and local communities are all looking for satisfying answers to these questions. Solutions will likely involve compromises on everyone's part.

"THE CAR IS NOW THE **designing technology** OF OUR BUILT ENVIRONMENT. IT **sets the form** OF OUR CITIES AND TOWNS, **dictating the scale** OF STREETS, **the relationship** BETWEEN BUILDINGS, **the need** FOR VAST PARKING AREAS, AND THE SPEED AT WHICH WE EXPERIENCE OUR ENVIRONMENT."

CALTHORPE, PETER. *THE NEXT AMERICAN METROPOLIS: ECOLOGY, COMMUNITY, AND THE AMERICAN DREAM.* PRINCETON ARCHITECTURAL PRESS, 1993

things to think about

Discuss these questions in small teams or as part of a larger group.

1. What are the characteristics of a traditional town? How do they affect transportation?

2. Which two are the consequences of today's land use patterns and the automobile?

   A. Traffic congestion

   B. Population increases

   C. Sprawling land use development patterns.

3. Describe how sprawl, suburbanization, and ruralization affect the use of energy, natural resources, and land.

4. What are zoning laws?

5. Name three types of pollution resulting from land use. Describe how each alters our health and the quality of our lives.

   1. _____

   2. _____

   3. _____

6. What causes land to be consumed, mobility trends to shift, and cars to be demanded in increasing quantities?

land ho! settling a brand new place

activity 4a

notes for instructors

Subjects: Environmental Science, Social Science.

Activity Outcomes:
Students should be able to:

- UNDERSTAND ISSUES AND TRADE-OFFS ASSOCIATED WITH ESTABLISHING A NEW COMMUNITY;
- GAIN KNOWLEDGE ABOUT THE PRINCIPLES OF LAND USE AND TRANSPORTATION PLANNING AND THE EFFECT PLANS HAVE ON THE ENVIRONMENT;
- LEARN HOW TO INTERPRET A TOPOGRAPHIC MAP.

Time Required: Two 45 to 60 minute sessions. The first one will be used for planning in teams; the second for the group planning meeting.

Equipment and Materials: Photocopy Activity 4a handouts #1, #5 and #6 for the group. Photocopy Activity 4a handouts #2, #3 and #4 and cut cards apart for team assignments. Each team should also get a master copy of Activity 4a handouts #2, #3 and #4, explaining what other teams' roles are.

Activity Overview

In this activity students have the opportunity to simulate building a community from the ground-up. They'll figure out the locations for and types of transportation, building, food production, shelters, energy sources, and businesses the new settlement needs and desires.

From National Science Education Content Standards

Content F-Science in Personal and Social Perspectives: Human populations use resources in the environment to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.

Populations can reach limits to growth. Carrying capacity is the maximum number of individuals that can be supported in a given environment. The limitation is not the availability of space but the number of people in relation to resources and the capacity of earth systems to support human beings. Changes in technology can cause significant changes, either positive or negative, in carrying capacity.

Doing the Activity

Explain to the group that, often, people have different ideas about what a community should offer. Some want to use their cars for every transportation need, and therefore demand many roads and gas stations. Others want a good public transportation system. Some want big houses on large tracts of land, while others want to save the land for food production and wildlife and build

smaller houses that are located close to each other.

In every community, people need water, electricity, and sewers. Children need schools, while nature lovers want open space and places to recreate. Businesses have to exist to provide merchandise to people and to create jobs that will support the spending. These needs and desires make up the expectations of a community. They affect natural resources and the environment by placing varying demands upon them.

If you haven't already had students read the Unit Background, let them do it now. After they are finished, discuss the questions from *Things to Think About* found on page 7. (Answers can be found in the back of this book.)

Next, hand out copies of Activity 4a handout #1 to each person. Explain to students that during this activity they will simulate building a community from the ground up, using the assumptions on the sheet. They will face the challenges of meeting the expectations of the people who will live there. Youth also will decide how their new community can grow sustainably. (Note: In actuality, few communities are put together from scratch, unless they are planned communities. Communities are sometimes relocated due to flood or other natural disturbance. Still, this activity will help students understand the complexities of meeting people's needs and wants with limited spaces and funding.)

ESTABLISHING PLANNING COMMITTEES

Divide the class into six teams, or committees, of community planners. The six committees are: Housing; Agriculture; Infrastructure; Education; Environment, Parks and Recreation; and Business and Commerce. Distribute committee information to each team (found on Activity 4a handouts #2-#4).

Appoint one member of each team as the chairperson of their committee (teams may wish to vote this person in). The chairperson also is the town planning commission representative and will speak on the team's behalf at a future town council meeting.

Give teams time to read their committee information about the planning assumptions, committee responsibilities, and zoning limitations.

USING TOPOGRAPHICAL MAPS FOR PLANNING

Next, give teams copies of Activity 4a handout #5, the topographical map of the newly planned community. Explain that topographical maps (topo maps) are three-dimensional interpretations of an area. They are built using contour lines, which show elevation. (Tell students to think of it as circling a hill, staying at the same elevation. The contour line could be drawn from their footsteps.) The closer the lines are spaced, the steeper the hill.

Review other information about topographical maps found on Activity 4a handout #6. Then, check how well students

can read this topo map. Ask them the following:

- Is the stream at Sand Bank Hollow, near point C, flowing east or west? (West. Remember, the closed end of the contour line points upstream.)

- You are standing at point E. What is your height above sea level? (Between 1140 and 1160. The darker contour line below is 1100. Lighter colored contour lines are at 20 foot intervals.)

- You are standing at point B near Brush Mountain. Can you see Thompson Hollow? (Yes, because you are on a high point, looking down into a valley.)

- Standing at point D, can you see Overall Run (south of point E)? (No, because you are standing in a valley, and can't see up and over the ridges.)

- If you follow the trail (dashed line) from point E to point C, are you:
  A. gaining elevation
  B. losing elevation
  C. remaining level
  D. losing and gaining elevation
  (D. - You are losing elevation at the beginning, and then start climbing again.)

- If you walk from point B to point D, are you:
  A. going up a steep hill
  B. going down a steep hill
  C. going up and down to get to point D
  (B. - You are going down a steep hill.)

Putting It All Together

Instruct teams to consider all assumptions and responsibilities and use the topo map to decide the best place to locate elements of the new community that teams are planning. Encourage them to interact with other teams to prevent ideas from becoming mutually exclusive. Each team should use paper, pens, markers, and posterboards to complete a committee document that includes:

- A complete a list of recommendations that fulfills its planning responsibilities.

- Written rationales for their recommendations.

- Suggestions they think other planning commission members should consider.

- Any drawings or exhibits that they think will help explain their recommendations.

The appointed chairperson for each team should guide his/her committee members to accomplish their tasks. The chairperson should get ready to report at the upcoming planning commission meeting. The chairpersons, and other members of the committees, should be prepared to discuss the entire plan.

activity 4a

The Planning Commission Meeting

Chair the meeting for your group. Start by asking committees to present their recommendations (five minutes per team). When teams are finished, ask participants:

- As it stands now, could this plan be implemented?
- Are there plans that conflict with how to use the land? Explain.
- How will we resolve these conflicts? Should the planning commission decide? Should future residents have a say?
- Will the proposed transportation system serve the community effectively? Why or why not?
- Which land uses causes the greatest need for automobile use? For public transportation use?
- What activities needed to support a community seem to have the greatest environmental impacts? Did some committees attempt to reduce the impacts? Explain.
- Will this community of 50,000 people enjoy a high quality of life given the group's design? Why or why not?
- How can this community, as a whole, design itself to be the most sustainable? Will it still be here in fifty years? Will it grow? What challenges face the community if its population doubles in the next twenty years?

Checking Progress

What were the positive and effective aspects of the group process used in developing the plan? What aspects of the group process could be improved to make work easier and minimize conflicts?

Optional Ideas

Using the map from Activity 4a handout #5 or a larger scale, 1:125000 version (available from the U.S. Geological Survey), let students make clay models of the topography of their new town. You may wish to start students with just a section (one square on the map from Activity 4a handout #5).

community planning assumptions and responsibilities

activity 4a
handout #1

Community Planning Assumptions and Responsibilities

ASSUMPTIONS

- The entire topo map area is available for settlement.
- The community will have 50,000 residents.
- The median family income is $ 27,500.00.
- There will be enough children to warrant one high school, two elementary schools, and two middle schools. Some students might want to walk to school.
- One public transportation system will be needed by citizens. Each family of four will have at least one car.
- Paved surfaces (roads, parking lots) must use no more than 1 percent of the total area.
- The new community will be somewhat isolated, making it expensive to get energy and fuel. Teams will want to generate the community's own electricity from the abundance of local natural resources that include water, coal, and lots of sun. You'll be able to get gasoline from a nearby oil refinery that a business has said it is willing to build.
- Due to its relative isolation, the community will need an airport.
- The people establishing the community are generally active and healthy. They like to go to the movies, ride bikes, hike, and play golf. Some prefer to shop, eat out, and skateboard at the mall. They also are water enthusiasts who want to have access to a lake for boating and swimming.
- The community economy will likely include some energy development, tourism (since it is a very scenic place), agricultural activity, and businesses (supermarkets, retail stores, etc.).
- The community founders are environmentally aware. You'll want to understand how the community's needs for energy will affect the environment, how housing patterns might affect land and agricultural production, and how driving cars might affect the view of the surrounding mountains.

community planning assumptions and responsibilities

activity 4a
handout #2

Housing Committee

Assumptions/Responsibilities: Your job is to decide where housing should be located. Assume that some people will want to live in town, while some will want to live out of town. Some want homes that are large on several acres of land, while others will live in medium- to high-rise apartment buildings. Consider any applicable zoning requirements (below) as well as aspects of the landscape that seem most appealing for housing. Think, too, about how people will get to schools, businesses, and other places. List what you think the impacts of housing will be to the community and the environment and how you might minimize these impacts.

Zoning Requirements: No housing may be located within 100 feet of a water source. Housing design must maximize energy efficiency. To accomplish this, houses must be located so that they get as much exposure to the sun as possible (hint: maximum sun exposure comes from the south and west). Housing developments must be located within one mile of access to forests or trails.

Agriculture Committee

Assumptions/Responsibilities: Your job is to decide what type of agriculture should be located in the community and its purpose (e.g., feeding the community, exporting products for sale). Paying attention to the zoning requirements, decide where to locate crops or livestock. Think about the impacts of livestock or agriculture on land and water. Recommend how to manage environmental impacts.

Zoning Requirements: All agricultural land used for food production (not including livestock) must be located at least two miles from industrial or sewage treatment facilities. If pesticides are used in any agricultural production, such activity may not occur within one mile of any residences or within 1.5 miles of any water source. (Assumption: At least one-half of this community's agricultural production uses pesticides to protect against crop-eating bugs and blights.)

community planning assumptions and responsibilities

activity 4a
handout #3

Infrastructure Committee

Infrastructure Committee: Assumptions/Responsibilities: Your team has the important job of linking the things community members take for granted when they move in—roads, sewers, water, communications, and energy. Considering the zoning requirements, decide where you think roads, sewers, water pipelines, and telephone and power lines should go, and why. Understand that people don't want to spend more than three minutes per mile commuting, so roads must be designed to accommodate the traffic. Don't forget public transportation plans and the airport. Remember to coordinate your work with the other planning teams.

Consider: The more spread out your roads are, the better the chance that your community will sprawl. When housing, roads, and services are introduced into a new area, animal and plant habitat is lost. As housing developments venture farther into undeveloped areas, sewers and other services must be provided. Who will pay for the new services—the new homeowners or all the taxpayers? Will habitat (sometimes dubbed "green spaces") be set aside in other areas to keep the area environmentally healthy?

Zoning Requirements: No roads or sewage treatment facilities may be located within one mile of any water source. All telephone lines must be either underground (very costly) or located so that they are hidden by forests or trees. Water for human consumption must come from lakes or reservoirs, not from rivers. Public transportation alternatives (bus or rail lines) must be available in commercial areas and to the airport.

Education Committee

Assumptions/Responsibilities: Your job is to make sure your new community has good schools that are located according to zoning requirements. This means you need to work particularly close with the housing planners and the business and commerce planners so that all zoning requirements can be met.

Zoning Requirements: All schools must be located either within one mile of most residential housing or along a bus route. All schools must be located at least 1.5 miles from any industrial facility (e.g., oil refinery or mining operation). All schools must be within one-half mile of a fire station.

community planning assumptions and responsibilities

activity 4a
handout #4

Environment, Parks and Recreation Committee:

Assumptions/Responsibilities: Your job is to locate all parks and recreational areas according to any zoning requirements. As you develop your recommendations, list what the facilities will be and why you think they need to be developed. Identify what you'll need from other planning teams to make your plan successful (e.g., roads, bus routes, buildings, telephone lines). Discuss impacts of recreational activities (e.g., foot traffic on the land) on the environment and how you might lessen them.

Zoning Requirements: No built parks or recreational activities may be located within two miles of an industrial facility. Parks and recreation uses may occur in wilderness areas as long as no permanent structures are located there (trails are acceptable). At least half the parks and recreational facilities must be located within one mile of residential or commercial buildings.

Business and Commerce Committee

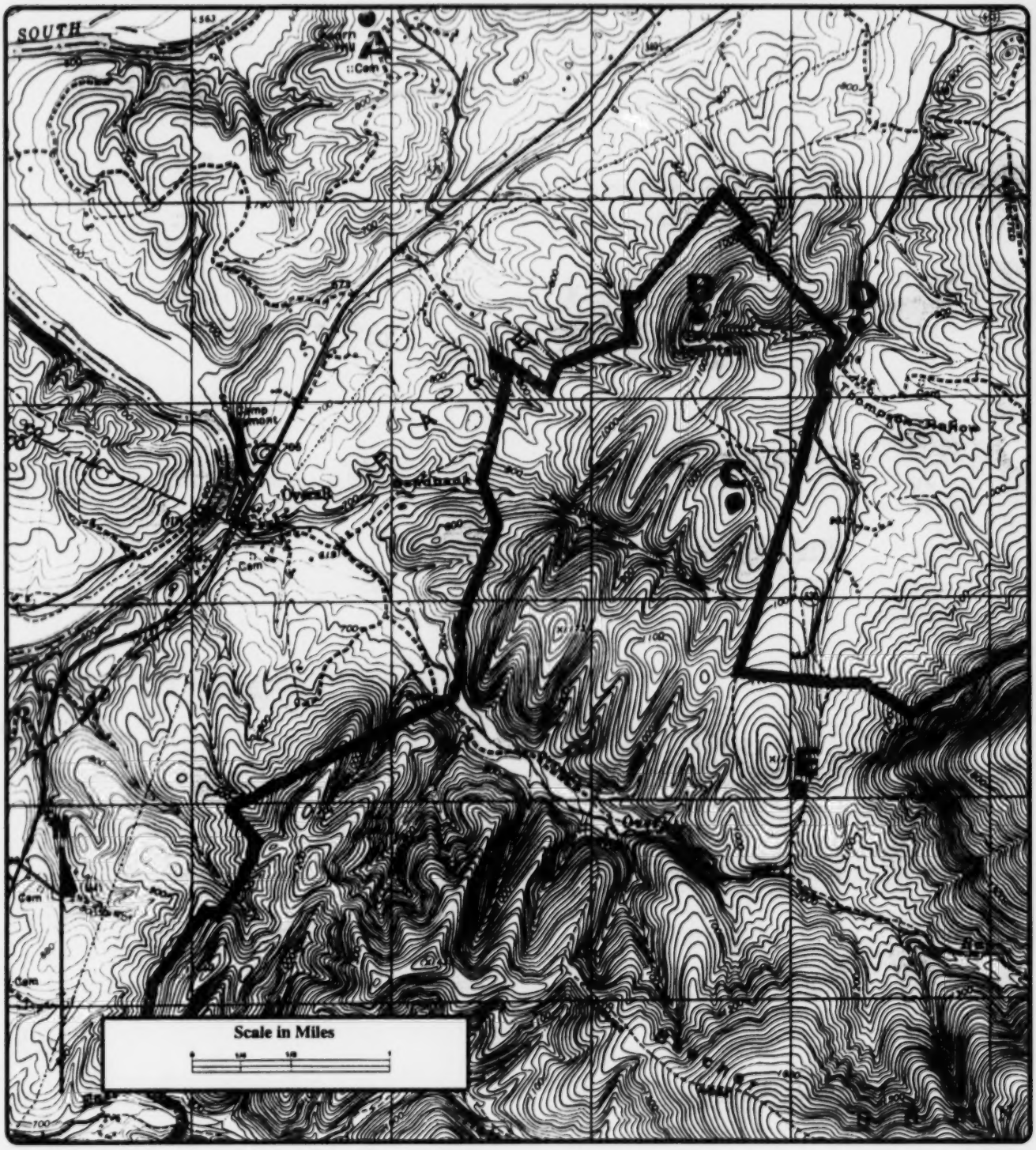
Assumptions/Responsibilities: Where should people in your community work? Shop for food? Buy clothing, furniture, computers, books, or fuel? Your job is to locate industrial and commercial buildings. These might include an oil refinery, offices, stores, restaurants, child care facilities, etc. Think about what your community will need and where the buildings should go. Pay close attention to the community planning assumptions and zoning requirements. Think about environmental impacts on the land associated with these activities and how you might lessen them.

Zoning Requirements: Any large manufacturers that burn fossil fuels (coal, oil, or natural gas) must be located at least two miles from any residence, child care facility, recreational facility, wilderness area, or water source. Commercial businesses (e.g., grocery stores, gas stations, beauty salons, sporting goods stores) should be located within walking distance (one-quarter mile) of public transportation routes.

BEST COPY AVAILABLE

topographical map

activity 4a
handout #5



topographical map

activity 4a
handout #6

1. Topographical maps (topo maps) are three-dimensional interpretations of the land and waterways.

2. Topo maps are made of contour lines (light lines) and show the elevation above sea level. Imagine traversing a hillside, not going up or down. This would be called a contour line. Or think of building a mound of dirt and marking concentric circles from the top to the bottom at one-inch intervals.

3. The tighter the lines on the contour map, the steeper the hill.

4. Markings on the map can show both natural (streams/lakes) and human-made creations (buildings, railroads, mines, roads, etc.). Streams are marked by blue lines, and stream directions are marked by Vs in the contour lines. The closed end of the v-shape points upstream.

5. Elevations are marked within the contour lines at various points.

6. The vertical black grid lines on the maps generally run north.

7. Most of the mountains are forested.

8. Always check the key at the bottom of the map to compute horizontal distance (1" = 1 mile).

resolving national park land use conflicts

activity 4b

notes for instructors

Subjects: Social Science, Environmental Science.

Activity Outcomes:
Students should be able to:

- LEARN TO ANTICIPATE OTHER POINTS OF VIEW IN LAND USE DILEMMAS;
- DISCOVER WHAT IS INVOLVED IN ANALYZING LAND USE ISSUES;
- LEARN ABOUT MULTIPLE-USE AND TRAFFIC ISSUES IN NATIONAL PARKS;
- EXPLORE ASSESSMENT AND CREATIVE THINKING PROCESSES FOR MANAGING PRESENT AND FUTURE CONFLICTS OVER LAND USE AND RELATED TRANSPORTATION ISSUES.

Time Required: Two 45 to 60 minute sessions.

Equipment and Materials: Copies of Activity 4b handout.

Activity Overview

This activity focuses on one of the primary examples of land use and transportation conflict today–public land disputes. Students anticipate and assess multiple land use needs and brainstorm ideas for traffic management in a national park. They figure out potential environmental impacts and conflict with other users.

From Benchmarks for Science Literacy:

Conflict between people or groups arise from competition over ideas, resources, power, and status.

Doing the Activity

If you haven't already had students read the Unit Background, let them do so now. After they are finished, discuss the questions from *Things to Think About*, found on page 7, in the large group. (Answers can be found in the back of this book.)

Discuss how we love our public lands, parks, and open spaces. For decades, these lands had remained relatively untouched by the majority of our nation's population. But times have changed. Recreation and a desire to "get away from it all" have increased the demands on public lands. Conflicts arise about who gets to use public areas. Often, these conflicts are related to automobile, hiker, bus, bicycling, all-terrain vehicle, and other transportation modes.

activity 4b

Other public lands also struggle with issues include:

- MOVING PEOPLE THROUGH THE PARKS WITH THE LEAST AMOUNT OF HABITAT AND OTHER ENVIRONMENTAL DAMAGE;
- OVERUSE AND EROSION OF SENSITIVE AREAS AND TRAILS;
- ACCOMMODATION OF PUBLIC NEEDS SUCH AS WATER, TOILETS, FOOD, GASOLINE, AND OTHER AMENITIES;
- CONFLICTING RECREATIONAL USES BY GROUPS AND INDIVIDUALS.

Explain to students that they will explore the issues related to overuse and conflicting demands on national lands. They'll learn what issues users have, how to anticipate user demands through research and interaction, and how to figure out how recreation and travel impact lands.

1. As a group, brainstorm all the potential user groups of public lands for a national park, dubbed Three Volcanoes National Park. (Your list probably will include hikers, horseback riders, car travellers, bicyclists, all-terrain vehicle recreationists, bird watchers, canoeists, anglers, etc.)

2. Divide into as many teams as there were user groups in your brainstorm session. Assign a user group to each team. Distribute Activity 4b handout to each team, and instruct them to write down all the user groups identified during the brainstorm session in column 1. (They may need more than one copy of the handout to do this.)

Next, ask teams to finish filling in the matrix by listing:

- THE NEEDS THAT EACH USER GROUP HAS (E.G., ALL-TERRAIN VEHICLE USER GROUPS NEED TRAILS). THEY SHOULD WRITE THIS INFORMATION IN COLUMN 2.
- THE POTENTIAL IMPACTS OF THE USER GROUP ON THREE VOLCANOES NATIONAL PARK. FOR EXAMPLE, WILL THE HORSEBACK RIDERS DAMAGE TRAILS AND CAUSE EROSION? THEY SHOULD WRITE THIS INFORMATION IN COLUMN 3.
- THE THREE USER GROUPS THAT THEIR GROUP MIGHT CONFLICT WITH THE MOST. FOR EXAMPLE, THE CANOEISTS MIGHT CONFLICT WITH ANGLERS OVER RIVER USE. WRITE THIS LIST IN COLUMN 4.
- DESCRIBE WHAT THESE CONFLICTS MIGHT BE IN COLUMN 5.
- IN COLUMN 6, LIST THREE POINTS THAT YOUR TEAM WOULD COMPROMISE ON IN A CONFLICT. FOR EXAMPLE, YOUR TEAM MAY AGREE TO GIVE UP FOUR ACRES FOR NEW TRAILS IF ANOTHER 100 ACRES WOULD BE SET ASIDE AS WILDERNESS.

Now ask teams to check their information in columns 4, 5, and 6. They should seek out members of the teams that they have anticipated conflict with. Their mission is to

come to a compromise or decision about use in the park. Note: Members of teams can approach other teams as a group, or send single delegates to other teams to negotiate. They should record these compromises at the bottom of the sheet.

After they are done, ask teams to assess their progress. Did they compromise yet still accomplish some of their goals? Were they overwhelmed by other teams? Did they have trouble justifying their needs? Ask teams to "grade" their efforts (1 = not very good, 5 = excellent).

Ask the large group which user group, in their opinions, ended up with the most gains, or rights. Which ended up with the least? Did they think the process was fair?

Checking Progress

Ask students how moving around public lands such as the fictional Three Volcanoes National Park causes conflict. Can they name any recent example of public lands (at least partly) closed to vehicle or human use, due to damage to the environment? (E.g., Grand Canyon tour airplane traffic; Yellowstone National Park snowmobile and buffalo conflicts; Yosemite National Park traffic congestion and air pollution). Should park managers be able to restrict vehicle or human traffic if it leads to habitat or other environmental damage?

Optional Ideas

Ask participants to track a current public land use issue in their community. They can research local newspaper articles (library or Internet for past issues), observing how the issue progresses or the problem is resolved. To better understand the issue, students can attend a town or city council meeting where this issue is being discussed and observe the process used for discussion.

activity 4b
handout

Column 1 Users	Column 2 Needs	Column 3 Potential Impacts	Column 4 Conflicting User Groups	Column 5 Conflict Descriptions	Column 6 Compromise Points

Compromises/Decisions Reached By Our Team: _____

_____

_____

answers
from page 7

Things to Think About

Answer #1: Traditional towns have walkable streets that lead from homes to schools, parks, grocery stores, bakeries, etc. This pattern affects transportation by requiring fewer streets and therefore less pavement. It also allows more transportation modes to be effective.

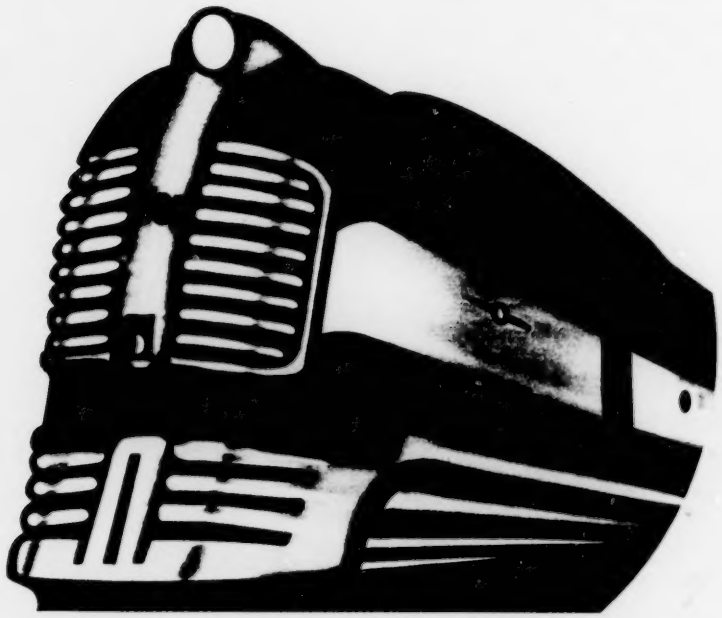
Answer #2: A and C.

Answer #3: As people need to cover greater distances to get where they are going, they use more fuel. This means we will use more nonrenewable resources, such as oil. It also means we must use resources to build roads. Habitat disappears, or becomes fragmented.

Answer #4: Zoning laws are created by a community's comprehensive planning effort. They are a set of regulations that explain what uses may be permitted on certain property.

Answer #5: Pollution resulting from land use includes litter, air pollution, surface water runoff, domestic wastewater, industrial wastes, water resources degradation, light and noise pollution. Air pollution, for example, alters our health by causing respiratory problems, such as asthma. Air pollution also thins the "good" ozone in the stratosphere. This lets in more ultraviolet radiation that can cause skin cancer.

Answer #6: Land is consumed, mobility trends shift, and more cars are needed when population increases, along with the desire for freedom to move around.



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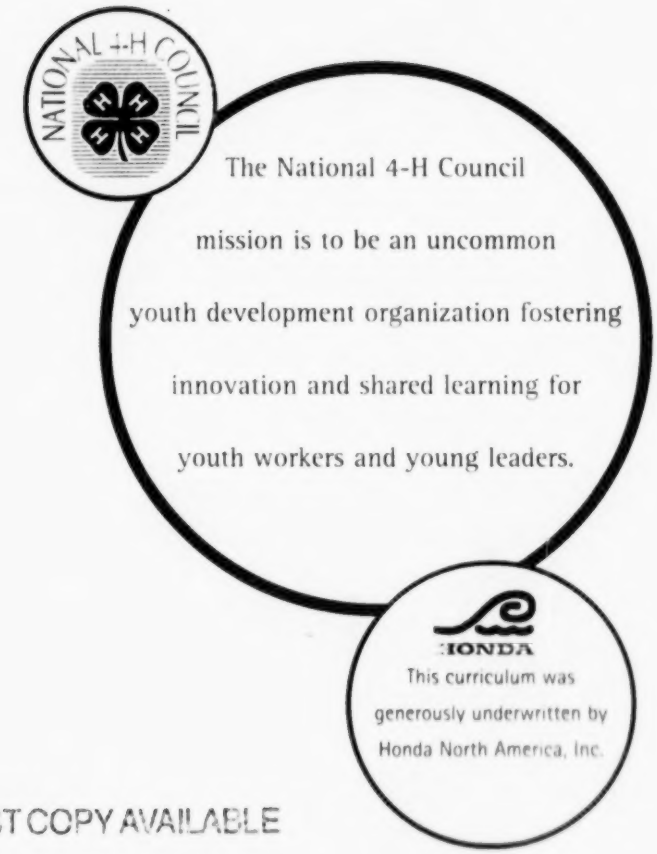
a matter of choice

unit 5

GOING PLACES, MAKING CHOICES, TAKING ACTION



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a matter of choice

unit 5

GOING PLACES, MAKING CHOICES, TAKING ACTION

EMBARK ON A new LEARNING adventure!

GOING PLACES, MAKING CHOICES:
TRANSPORTATION AND THE ENVIRONMENT

CURRICULUM DESIGNED FOR GRADES 9-12

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Unit 5 Contents

GOING PLACES, MAKING CHOICES
Transportation and the Environment

Introduction

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Unit 2	Natural Resources and Energy Use
Unit 3	Sweating Over Climate Change: Air Pollution and Climate Change
Unit 4	Land Use: Leaving Our Imprint on the Earth

A MATTER OF CHOICE
Going Places, Making Choices, Taking Action

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Website Resources

The websites listed here will give students access to ideas and information. Please note these addresses can change. Students can use keywords such as *environmental ethics* and *environmental beliefs* to search the Internet and find other sites. Let them explore!

- GOING PLACES, MAKING CHOICES
  www.fourhcouncil.edu/ycc/gpmc/index.html
- CENTRE FOR APPLIED ETHICS
  www.ethics.ubc.ca/resources/environmental/eth-inst.html
- CENTER FOR ENVIRONMENTAL PHILOSOPHY
  www.cep.unt.edu/
- ENVIRONMENTAL ETHICS AND PUBLIC POLICY PROGRAM HARVARD UNIVERSITY
  http://divweb.harvard.edu/csvpl/ee
- INTERNATIONAL SOCIETY FOR ENVIRONMENTAL ETHICS
  www.cep.unt.edu/ISEE.html
- TECHNOLOGY, BUSINESS AND ENVIRONMENT PROGRAM AT M.I.T.
  http://web.mit.edu/org/c/ctpid/www/the/
- ASSOCIATION FOR THE STUDY OF LITERATURE AND ENVIRONMENT
  www.people.virginia.edu/~djp2n/asle.htm

a matter of choice

unit 5

TOURGUIDE NOTES

Unit Destination

The goal of Unit 5 is to help learners explore the correlation between what they personally believe and how they choose to act. Values are deeply held beliefs ingrained since childhood. In today's world, our values can be tracked by observing how we think, act, and even spend our money. In fact, the relationship between values and economics in society to a large degree dictates our future. When a culture begins to value new ideas and specific outcomes, society shifts its preferences.

Learning Objectives

Students will:

- LEARN HOW PERSONAL VALUES SHAPE THE EVERYDAY WORLD—FAMILY LIVES, EDUCATION, POLITICS, FAITH, VISION, AND HOW WE CHOOSE TO SPEND MONEY;
- INVESTIGATE PERSONAL VALUES AND HOW THESE AFFECT THE CHOICES THEY MAKE AS INDIVIDUALS AND CONSUMERS—AT THE MALL, ON MAIN STREET, AT SCHOOL, WORK, PLAY, ETC.

UNIT BACKGROUND

It is no coincidence that this curriculum begins and ends with the notion of freedom. Freedom of choice will determine how well humans face their environmental dilemmas. It's been said that science can help build a bomb but can't tell us anything about whether it is right or wrong to drop it. As human innovation and technology advance, it will be critical to revisit and clarify basic values.

Origins of Environmental Thinking

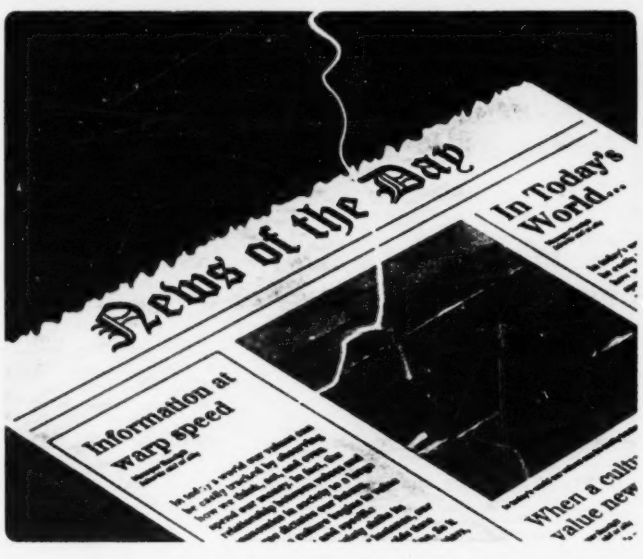
In the United States, our democracy was built on political ideologies and on the assumption that natural resources were infinite. Today we see this is no longer true. President Theodore Roosevelt and Gifford Pinchot, the first director of the U.S. Forest Service, were two of the many visionaries who saw the need to protect our great natural areas by establishing national parks and forests. Aldo Leopold, author of *The Sand County Almanac*, helped generations fall in love with wilderness areas. Many believe the modern environmental movement began in the 1960s with Rachel Carson's book *Silent Spring*, warning of environmental harm from the unchecked use of pesticides. She also helped us understand that technology often brings with it as many costs as benefits.

The environmental movement is a symbol of our public values. Since Earth Day's debut in 1970, environmental protection has held a firm place in the American political agenda. The formation of the U.S. Environmental Protection Agency and numerous environmental regulations are expressions of our collective environmental values. Though there is sometimes controversy surrounding the effectiveness of environmental laws, they are nonetheless proof that the environment is valued by the public.

Freedom in an Environmentally Sensitive World

What does it mean to be free—to live in a free country? What environmental obligations, if any, does freedom entail? And

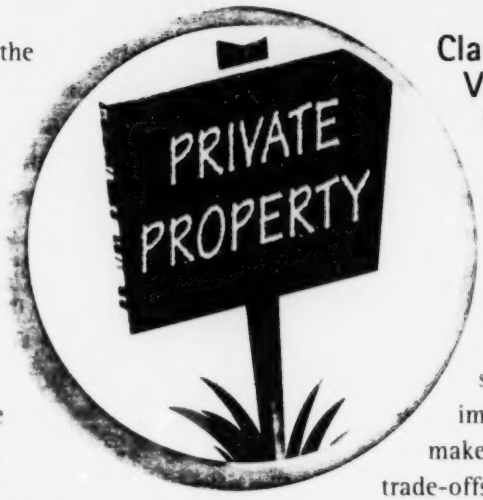
consider this:



In your lifetime, information and decisions will come at lightning speed. A weekday edition of the New York Times contains more information than an average person was likely to come across in a lifetime in seventeenth-century England.

Richard Saul Wurman, *Information Anxiety*, New York: Doubleday, 1989

what is the role of the individual in upholding this freedom?



Originally freedom meant the ability to live one's life without fear of violence or damage to private property. The Western world inherited its notion of basic human rights from great 17th century political philosophers, such as John Locke, Thomas Hobbes, and Jean-Jacques Rousseau. Enlightenment thinkers of the 18th century, such as Thomas Jefferson, translated these concepts into the familiar notions of inalienable rights. They created a political foundation for the democratic society we live in today. Using a fairly narrow definition of "rights," the framers of our Constitution outlined a social order intended to protect individual freedom while preserving peace and order.

Environmental damage reminds us that freedom comes with a price—the compromises we must make to preserve our environment. As natural resources become increasingly scarce, as human health is exposed to environmental hazards, and as pristine wilderness areas become more the exception instead of the norm, we have to reconsider our notions of freedom.

Giving up personal freedoms to make society as a whole work better is not a new idea. For instance, you are not free to rob a bank, but because bank robbery is illegal, our society is freer for all.

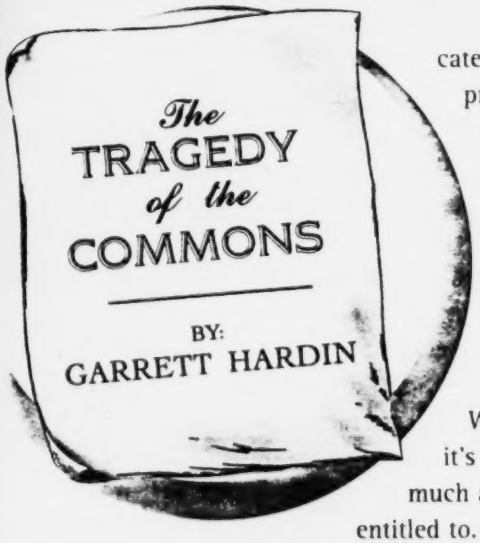
Clarifying Environmental Values: Some Important Concepts

1. Trade-offs You've probably heard the saying, "there is no such thing as a free lunch." Every action has a consequence. Some consequences are obvious, some are not. Some are immediate, some are gradual. We make choices every day that involve trade-offs. Ideally, we know what the trade-offs are (for example, the health risks that accompany smoking).

The trade-offs of environmental choices are often hard to figure out. Environmental damage often involves long-term effects that are difficult to measure. As a result, we just ignore them. Building a hydroelectric dam, for example, may have environmental trade-offs—alteration of habitat, damage to fisheries—that are not considered until it is too late.

2. Private versus Public The Declaration of Independence and the U.S. Constitution describe the "right to property" as "private property." Because much of the land in the United States is publicly owned, many of our natural resources do not fall into the

> "WE MUST NOT, IN TRYING TO THINK ABOUT HOW WE CAN MAKE A **big** DIFFERENCE, IGNORE THE SMALL **daily** DIFFERENCES WE CAN MAKE WHICH, OVER TIME, **add up** TO BIG DIFFERENCES THAT WE OFTEN CANNOT FORESEE."
>
> —MARIAN WRIGHT EDELMAN. *FAMILIES IN PERIL*, CAMBRIDGE, MA: HARVARD, 1987



category of private property. This means that many natural resources do not enjoy the same protection or rights that privately owned resources enjoy.

We all own the air, but it's hard to measure how much air each person is entitled to. It is harder still to assess damage when that air is contaminated. If your neighbor is caught dumping toxic chemicals in your front yard, you can have him arrested. You have legal protection through laws governing private property.

We all own Prince William Sound in Alaska, where there was a huge oil spill many years ago. But it would be almost impossible to pay back the American public for this spill. How would the damage be quantified? Who would decide what a fair damage price is? What's an otter worth? What is clean water worth? Does nature have rights? What right does an individual citizen have to clean air and water? Because our resources are in the public domain, they pose unique problems that environmental values and policy must address.

3. Tragedy of the Commons In the 1960s Garrett Hardin wrote a famous article entitled "The Tragedy of the Commons." Hardin argued that our most serious global problem is unchecked population growth. The devastating consequence of this is that public goods–the "commons"–will ultimately be destroyed by individual citizens. This is inevitable, he argued, because individuals have no incentive to give up something–to sacrifice–especially when there is no system in place to ensure that others will do the same. You might not want to take the bus to work on a snowy day to conserve fuel, for example, if your neighbor is taking a warm car from his garage.

The message here is that as long as natural resources are in the public domain, they will be discounted by individual users. This is not a commentary, Hardin argues, on the depravity of human nature. Rather, it is an analysis of the kinds of decisions that are most rational where the environment is treated as a commons.

Environmental Ethics and Personal Responsibility

Why would people voluntarily restrict their choices to lessen environmental impacts? Here are a few reasons:

1. Enlightened Self-Interest Perhaps the most indisputable reason for behaving in an environmentally responsible manner is self-interest. "What's in it for me?" is at the heart of most decision making. Thus, it is important that each of us understands what's at stake for ourselves.

2. Citizenship Good citizenship means acting in the interest of the group rather than the individual. Before the advent of Western individualism in the 17th century, people's worth was defined by their role in a larger community.

it's a fact

WHEN ASKED WHAT **single event** WAS MOST HELPFUL IN DEVELOPING THE **theory of relativity,** ALBERT EINSTEIN IS REPORTED TO HAVE ANSWERED, "FIGURING OUT HOW TO **think about the problem.**"

SCHRAMM, WILBUR, AND PORTER, WILLIAM. *MEN, WOMEN, MESSAGES AND MEDIA: UNDERSTANDING HUMAN COMMUNICATION*, NEW YORK: HARPER AND ROW, 1982.

Environmental damage is the total of many individuals making small choices. When you consider environmental impacts and choose to take the bus, carpool, or ride a bike, you're considering the welfare of the whole. This is the essence of good citizenship.

3. A Sense of History and Continuity
Through the course of human history, nature has been praised, blamed, conquered, changed, protected, but always depended upon. Many of our greatest human accomplishments—works of art, literature, music—have been inspired by the natural world. Because nature is such an integral part of our lives and culture, we are compelled to respect and perpetuate it.

4. Obligations to Future Generations
Today we are encouraged to value the present over the future. You can have it now—no money down! We are encouraged to consume now and pay later. Our capitalist economy is, in many ways, addicted to growth. This growth depends on people consuming ever-increasing amounts of goods at ever-increasing rates.

Environmental stewardship requires thinking of future generations. However, it is unrealistic to expect individuals to change their behavior for the sake of future generations unless they place some value on future generations to begin with.

5. The Environment: An Ethical Issue
The interaction between humans and the environment is often viewed in the context of right or wrong—an ethical issue. Ethics can motivate people toward certain outcomes. Ethics also can be an expression of a person's sense of self, and a reflection of self-respect.

what is a wilderness worth?

THE FIELD OF ENVIRONMENTAL ECONOMICS OFFERS UP THE FOLLOWING OPTIONS FOR VALUING NATURAL AREAS:

- THEY ARE PRICELESS AND MUST BE PRESERVED AT ALL COSTS.
- THEY ARE WORTHLESS, SINCE UNUSED RESOURCES AND UNDEVELOPED LAND DON'T GENERATE BENEFITS OR INCOME TO HUMANS.
- THEY ARE WORTH THE SUM OF THEIR PARTS. ADD UP THE MARKET VALUE OF ALL THE NATURAL RESOURCES THAT COULD BE HARVESTED OR EXTRACTED.
- THEY ARE WORTH THE AMOUNT OF TOURISM EXPENDITURES THEY GENERATE.
- THEY ARE WORTH WHAT PEOPLE ARE WILLING AND ABLE TO PAY FOR THEM.

SOURCE: *ENERGIZING YOUR FUTURE WITH ENERGY, ECONOMICS AND ENVIRONMENT.* CHEVY CHASE, MD: NATIONAL 4-H COUNCIL, 1997.

Wouldn't those committed to ethical thinking eventually consider the environmental impacts of their actions? Environmental choice-making constantly arises in public dialogue as an ethical consideration.

6. Connection to Nature

The Endangered Species Act of 1973 recognizes the inherent value of wildlife as well as our obligation to protect it from extinction. To many, humans are an intricate part of nature. Environmental destruction thus harms us, too.

This connection to nature is apparent in our daily lives. Just witness the widespread use of the marketing term "natural" on everything from shampoo to herbal tea. We frequently use "natural" as an indication of approval or an assurance of quality. Natural is contrasted with something that is manufactured or synthetic. This shows that our connection to all things natural runs deep. This should be reason enough to check those actions that cause damage to the natural world.

things to think about

Discuss these questions in small teams or as part of a larger group.

1. President Theodore Roosevelt, Gifford Pinchot, Aldo Leopold, and Rachel Carson are considered environmentalists. Can you name others?

2. Give an example of a trade-off in an environmental choice.

3. Name a forest, park, or other natural space in your area. Explain one method for calculating its worth.

4. Explain the tragedy of the commons and give an example of the concept.

5. Explain why people might act ethically toward the environment.

what's driving our decisions?

activity 5a

notes for instructors

Subjects: Social Science, Earth Science.

Activity Outcomes:
Students should be able to:

- UNDERSTAND HOW VALUES INFLUENCE BEHAVIOR;
- LEARN HOW THINKING AND BELIEFS ULTIMATELY TRANSFORM CHOICES.

Time Required: 45 minutes.

Equipment and Materials: Photocopies of handouts for Activity 5a.

Activity Overview

Students build an awareness of how values influence behavior. They reflect on their own values and complete a short assessment. This activity provides insight into decision-making processes and how we all weigh costs and benefits, needs and desires.

From Benchmarks for Science Literacy:

View science and technology thoughtfully, being neither categorically antagonistic nor uncritically positive.

Doing the Activity

As an introduction to the topic, hand out copies of the Unit Background from this book. Each person is responsible for reading and understanding the material. After they are finished, they should spend time within teams or in the large group discussing the questions from *Things to Think About*, found on page 7. (Answers are in the back of this book.)

Ask students: How do they make choices? Do they make conscious decisions about what they need or want? What are their criteria for purchases? What are the values that affect these buying decisions? Do their decisions take the environment into account?

Remind students that the choices we make every day affect the environment. In fact, although we often feel disempowered and think "I can't make a difference," we all can change some part of the world.

activity 5a

Give everyone a copy Activity 5a handouts 1.1 and 1.2. Give students about 10 minutes to answer the questions. Tabulate responses as a group, and calculate means for each question. (Assign each response a "1," "2," "3," "4," or "5" to do this.) Review each question again and point out where the majority falls. Does this surprise the group? Discuss:

1. Did any of the beliefs and attitudes you circled impact the decisions you made recently? Give an example.

2. Do you think this group, as a whole, shows evidence of being good environmental citizens? Why or why not?

3. Understanding the attitudes reflected here, what would you expect the environment to look like in 10 years? 50 years?

4. How might this group's thinking affect future transportation in our community?

Next, distribute copies of Activity 5a handouts 2.1 and 2.2. Give students time to fill in the Attitudinal Factors. After they are finished, designate one area of the room as corresponding to the answer "1." In a straight line from this, designate another area as "10."

Now read each question from Activity 5a handouts 2.1 and 2.2. Ask students to align themselves on the continuum according to their beliefs. Those who believe solely in anthropocentrism, for example, will correspond to "1" and will stand on one end of the line. Those who believe solely in biocentrism will be "10" and will stand at the far end of the line. Others will fall in-between. Observe where most fall.

After they are finished, ask the group again, "What will the environment of our community look like in 50 years?"

Checking Progress

Ask students to write an essay about what their communities will look like in 50 years, using the perceptions and opinions of the group as the basis for their thinking. This can be added to their portfolios. In their essays, did students:

___ Anticipate change?

___ Prepare contingency plans?

___ Express their values?

___ Express their opinions?

___ Write persuasively?

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attitude and value assessment

activity 5a
handout #1.1

A SELF-DISCOVERY EXERCISE

1. Which of the following statements do you feel is MOST true?

- **a.** Humans are the most important creatures on earth; we ought to manage natural resources carefully for our own good.
- **b.** All living things are valuable; humans owe it to other life forms to treat the earth with care.
- **c.** Humans are the most advanced form of life; therefore, we have responsibility for the fate of the earth.

2. Which of the following statements do you feel is MOST true?

- **a.** As long as I take responsibility for my own needs, I don't owe anything to anyone.
- **b.** I will not be able to achieve any of my goals without the help of many other people.

3. If you had a gift of $1,000.00, how would you prefer to spend it?

- **a.** An encyclopedia on CD-ROM.
- **b.** A shopping trip (clothes, CDs, jewelry, sports equipment, etc.).
- **c.** A deposit in a savings account for college.
- **d.** A charitable donation.
- **e.** A down payment for a transportation mode (car, bike, motorcycle, etc.).

4. Which of the following statements do you feel is MOST true?

- **a.** I am willing to make a sacrifice when I can see how it will eventually help me.
- **b.** I am willing to make a sacrifice when I think it will help improve my relationships with others.
- **c.** I am willing to make a sacrifice when I think it will make me a better person.
- **d.** I am willing to make a sacrifice when I really believe it is what's right.

5. Which of the following statements do you feel is MOST true?

- **a.** The actions of one person do not matter much.
- **b.** The actions of one person can make a small difference sometimes.
- **c.** The actions of one person always make a small difference.
- **d.** The actions of one person can help change an entire system.

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attitude and value assessment

activity 5a
handout #1.2

A SELF-DISCOVERY EXERCISE

6. Which of the following statements do you feel is MOST true?

- **a.** Nonscientists can't understand many of today's complicated environmental issues.
- **b.** Any intelligent person can understand environmental problems if they just take the time to find out.
- **c.** No one, not even scientists, really knows whether environmental problems are serious.

7. Which of the following statements do you feel is MOST true?

- **a.** Environmental science is not very important, since there is not much we can do to improve the situation.
- **b.** Scientists can be counted on to provide us with sound information so environmental problems can be solved.
- **c.** Everyone has a responsibility to study environmental issues on their own.

8. Which of the following statements do you feel is MOST true?

- **a.** My idea of a special place is in front of a work of art in a museum.
- **b.** My idea of a special place is at a concert hearing my favorite band.
- **c.** My idea of a special place is under a large tree by a pond or lake.
- **d.** My idea of a special place is in a cafe with a close friend.
- **e.** My idea of a special place is in front of a TV watching my favorite show.

9. Which of the following statements do you feel is MOST true?

- **a.** It is pointless to worry about environmental problems we can't control or fix.
- **b.** If more people cared, many of our environmental problems would be resolved.
- **c.** I would like to do whatever I personally can do to improve environmental quality.
- **d.** I will make changes in my actions only if I am sure other people will do it, too.

10. Which of the following statements do you feel is MOST true?

- **a.** Life is complicated enough without having to worry about our great-great-grandchildren.
- **b.** I would like to leave a healthy planet for my descendants, but I do not believe it is possible.
- **c.** People have an obligation to think about how their actions will impact the earth's environment for future generations.
- **d.** I am not going to have children because I wouldn't want them to face the environmental damage our society is causing.

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attitudinal factors that influence our choices

activity 5a
handout #2.1

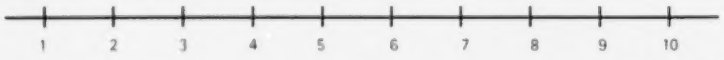
Environmental values and choice-making may be understood through the analysis of a number of attitudinal factors. Great philosophers and psychologists have studied human attitudes and beliefs for thousands of years. Some of these concepts are listed below. Circle where you are on these continuums.

1. ANTHROPOCENTRISM/BIOCENTRISM

Anthropocentrism: Perceives humans as the center of the universe; all choices are made with human beings in mind first.

Biocentrism: Perceives the natural world as whole; believes nature is not here for the sole purpose of human use. Humans are only regarded as part of nature, not above it.

Where I am on the A/B continuum:



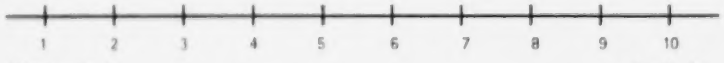
anthropocentric biocentric

2. INDIVIDUALISTIC/HOLISTIC

Individualistic: Perceives self as independent from others and the world, not affected by or affecting the whole. Prioritizes individual, personal concerns first.

Holistic: Considers self as part of larger fabric, integral to the whole system; rates social concerns first.

Where I am on the I/H continuum:



individualistic holistic

3. VALUING PRESENT/FUTURE (SOCIAL DISCOUNT RATE)

The level at which one discounts the importance of the future over the present: "It is more important to live for today because we don't know what will happen tomorrow—it doesn't matter if species go extinct because we'll be extinct too."

Where I am on the P/F continuum:

value present value future

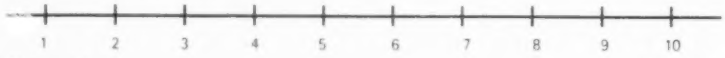
attitudinal factors that influence our choices

activity 5a
handout #2.2

4. PHILOSOPHICAL THINKING/PRAGMATIC THINKING

Philosophical: Views that are morally based, ethical in nature, contemplative.
Pragmatic: Views that are based on practical evaluation of a given situation.

Where I am on the Ph/Pr continuum:



philosophical pragmatic

5. SENSE OF INEFFECTIVENESS/PERSONAL EFFICACY

Sense of Ineffectiveness: Belief that one cannot make a difference.
Personal Efficacy: Belief that one can make a difference.

Where I am on the SI/PE continuum:

ineffectiveness personal efficacy

6. EXPERT/LAYPERSON DICHOTOMY

Expert: Belief that science should be left to the experts; they understand data and research.
Layperson: Belief that scientists may not know all the answers; questions data as truth.

Where I am on the E/L continuum:

expert layperson

gear up for community service

activity 5b

notes for instructors

Subjects: Social Science, Earth Science.

Activity Outcomes:
Students should be able to:

- EXECUTE A PROJECT THAT DEMONSTRATES THE SCOPE OF THEIR LEARNING IN TRANSPORTATION AND THE ENVIRONMENT;
- DEVELOP AND IMPLEMENT A PLAN TO SHARE LEARNING WITH OTHERS;
- ORGANIZE SUCCESSFUL COMMUNITY SERVICE PROJECT.

Time Required: 50 minutes for activity; more time for community service effort.

Equipment and Materials: Photocopies of Activity 5b handouts #1 and #2; other supplies as needed.

Activity Overview

This activity engages students in a community service project that is designed to take multiple weeks. You can decide to do a described emission-reduction program, or brainstorm a different community project with the group.

From Minnesota K-12 Science Framework:

Service-learning integrates community service into the school curriculum. Young people engage in community activities when they apply their academic knowledge and skills as they solve real-life problems. At the same time, these activities help students realize the importance of having a good understanding of science concepts, the meaning of citizenship, and their ability to help determine the quality of life in their communities.

Doing the Activity

If you haven't already done so, make sure students understand the content for this unit by letting them read the Unit Background and answer the questions in *Things to Think About*, found on page 7. (Answers are found in the back of this book.) They can answer questions as part of small teams or a large group.

Making changes in the world starts in our own homes and communities. Reinforce the concept from the Unit 5 Background of being a pro-active participant in changing situations. Explain that in Stephen Covey's book, *The 7 Habits of Highly Effective People* (New York: Simon and Schuster,

1989), problems and problem solving are divided into two areas:

- CIRCLE OF INFLUENCE: PROBLEMS THAT FALL WITHIN OUR CIRCLE OF INFLUENCE ARE THOSE THINGS THAT WE CAN AFFECT OR ARE ABLE TO CHOOSE OUR RESPONSE.

- CIRCLE OF CONCERN: PROBLEMS THAT FALL WITHIN OUR CIRCLE OF CONCERN ARE THINGS THAT ARE OUTSIDE OF OUR CONTROL OR THOSE THAT WE CANNOT DIRECTLY INFLUENCE BUT REMAIN A SUBJECT OF OUR DISCONTENT.

The key for community action (also dubbed service learning) is to focus on those problems or situations that fall within our circle of influence. Take pollution as an example. In our circle of concern are worldwide pollution levels and in our circle of influence are local pollution levels. It is difficult to change manufacturing or automobile emission rates in other countries. However, on a local level we can make choices about our own transportation modes as well as influence others' choices.

Action Option I: Reducing Pollution and Greenhouse Gases with Alternative Transportation

Distribute Activity 5b handout #1 to the group. This is a community action project that the class or larger school community can undertake. The goals are to reduce carbon monoxide, nitrous oxide, and other emissions by reducing automobile use.

Point out that there are certain situations where automobiles best meet the needs of the traveller. A car gets participants to their destination more quickly than most other forms of transportation. It also allows freedom coming and going according to your own schedule. However, undoubtedly there are situations where automobiles are used out of habit. Help students think and discuss some times when non-motorized form of transportation, such as bicycling, walking, or skating, might suffice for transport.

Now hand out multiple copies of Activity 5b handout #2 to participants. Ask the group to define who will participate in the community service project—will it just be the members of the class (or club), or will the greater community participate? Define the length of the project—one week? One month? Instruct participants to use Activity 5b handout #2 to record their emission savings. They may wish to set total emission reduction goals.

Participants can keep a running tally as they progress through the project. They may decide to make posters or other visual aids to help keep participants motivated. At the end of the project period, tabulate the results. Did the group meet their goals?

Don't forget to celebrate the accomplishment! Try one of the following:

- CONTACT THE LOCAL NEWSPAPER TO DO A STORY ON YOUR PROJECT;

activity 5b

- TAKE PHOTOGRAPHS AND CREATE A PUBLIC DISPLAY;
- HAVE A GROUP GET-TOGETHER.

Action Option II: Brainstorming Other Community Projects

Help the group brainstorm several activities that put their values and ideas to work. Some ideas to use to get them started include:

- ADOPT A SECTION OF HIGHWAY TO KEEP FREE OF LITTER;
- WORK WITH YOUR SCHOOL TO IMPROVE BIKE FACILITIES;
- WRITE AND PRESENT A PLAY ABOUT BICYCLE OR SKATING SAFETY;
- COLLECT AND FIX UP DONATED BICYCLES TO GIVE TO YOUNGER CHILDREN;
- DEVELOP A RECYCLING PLAN FOR YOUR SCHOOL;
- HELP PLANT SHRUBS, TREES, AND OTHER PLANTS AT A TOWN GREENWAY PROJECT.

From their brainstormed list, participants should choose a community service project that they may want to try. Ask them if the project meets these criteria:

- DO WE HAVE THE TIME TO DO THIS PROJECT WELL? (YES, NO, MAYBE?)
- IS THE PROJECT LOCAL AND THEREFORE WITHIN OUR REACH? (YES, NO, MAYBE?)
- WILL WHAT WE DO REALLY MAKE A DIFFERENCE? (YES, NO, MAYBE?)
- ARE WE REALLY EXCITED ABOUT AND COMMITTED TO THIS PROJECT? (YES, NO, MAYBE?)
- DOES THE PROJECT REALLY REFLECT WHAT WE BELIEVE? (YES, NO, MAYBE?)
- DOES IT REFLECT WHAT WE LEARNED ABOUT TRANSPORTATION AND THE ENVIRONMENT? (YES, NO, MAYBE?)

Explain that organizing a project is a big job, and requires a deliberate approach and follow-through. Work with the large group to do the following:

- DEFINE PROJECT GOALS;
- IDENTIFY THE PROJECT'S TARGET;
- CLARIFY ANTICIPATED RESULTS;
- DETERMINE TIME-FRAME AND SPECIFIC DATES;
- CONSIDER RESOURCES/PEOPLE THAT WILL BE NEEDED;
- SET SCHEDULE AND DISTRIBUTE TO ALL PARTICIPANTS;
- DEFINE GROUP MEMBER ROLES AND ACTIONS;

- DETERMINE YOUR REWARD WHEN YOU MEET YOUR GOAL.

Checking Progress

Evaluate student performance through observation. Did participants attend sessions? Were they enthusiastic and did they participate? Did they help in the physical development of the project?

Also, if students have kept portfolios of their activities and accomplishments, assess them now. They should be encouraged to write self-evaluations about how the experiences affected them.

Optional Ideas

Encourage students to prepare a short lesson that they can present to elementary school children about school bus safety. They should work with the company (or company materials) to design messages and lessons about boarding and unboarding safely, how to behave near a bus, looking both ways, how to stay safe on the bus, and how riding the bus helps the environment. Students should first pilot test their lessons on each other, change the lessons based on feedback, and then implement with elementary school children.

reducing pollution and greenhouse gases with alternative transportation

activity 5b
handout #1

HOW MUCH POLLUTION AND GREENHOUSE GASES CAN YOU PREVENT?

Weekly trips replaced (average of 3 miles per trip)	Pollution and Greenhouse Gases Prevented Each Week If You Bicycle, Walk, or Use Other Non-Motorized Transportation * Based on 20 mpg for cars		
	Pounds of Carbon Monoxide	Pounds of Nitrogen Oxides	Pounds of Carbon Dioxide (Greenhouse Gas)
2 trips	.2	.03	5.8
5 trips	.6	.06	14.1
10 trips	1.2	.12	28.2
15 trips	1.8	.18	42.3

Generally, each mile replaced saves .04 pounds of carbon monoxide, .0045 pounds of nitrogen oxides, and .98 pounds of carbon dioxide.

reducing pollution and greenhouse gases with alternative transportation

activity 5b
handout #2

1. During the next week/month, record all the bicycling, walking, or other non-motorized trips you take that replace automobile use.
2. Check if you obeyed traffic laws. It doesn't help if you put yourself in danger by not following the rules, like wearing a helmet or using hand signals, that keep you safe.
2. Add the total number of miles saved by the group.
3. Calculate the amount of carbon monoxide, nitrogen oxides, and carbon dioxide emissions reduced by the group using Activity Sheet 5.2A.

	I Obeyed All Traffic Laws	Number of Miles Travelled (Round Trip)	Total Carbon Monoxide Emissions Saved	Total Nitrogen Oxide Emissions Saved	Total Carbon Dioxide Emissions Saved
I Rode My Bike To:					
SUBTOTALS	xxxx				
I Walked To:					
SUBTOTALS	xxxx				
I Skated or Used Other Non-Motorized Transportation To:					
SUBTOTALS	xxxx				
TOTALS	xxxx				

answers
from page 7

Things to Think About

Answer #1: Answers will vary.

Answer #2: Example of a trade-off: "If I drive to school everyday, I'll be on time and have more freedom. But I trade that against cleaner air."

Answer #3: You might decide the area is priceless, worthless, worth the sum of its parts, worth whatever tourists will pay to view it, or worth whatever the market will bear.

Answer #4: The Tragedy of the Commons holds that public goods will ultimately be destroyed by individual citizens, since they are unwilling to sacrifice. For example, air is polluted by people making transportation choices based solely on convenience.

Answer #5: They might have an enlightened self-interest, a sense of history, or a sense of obligation toward future generations. Or, they might be ethical, good citizens, or connected to nature.

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